WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

Vol. LXXIX, No. 6

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LEADING ARTICLES To Appear in the Next and Subsequent Issues:

How a difficult manganese problem at the water treatment plant of Providence, R. I., was solved by substituting lime and iron coagulation for alum coagulation is described in a forthcoming article by E. C. Craig, E. L. Bean and R. W. Sawyer.

The matter of existing stream pollution and waste and the consequent savings effected by re-use of white water in paper and boxboard mills is treated by L. M. Booth in an article on "Water Supply for the Paper Industry."

Operating problems and costs of operation at five sewage treatment plants in Illinois form the subject matter of an article by H. E. Hudson, Jr., which will appear in an early issue.

An interesting article on the important subject of effective control of meter reading will be a contribution by L. D. Shively, chief meter reader, Indianapolis Water Co.

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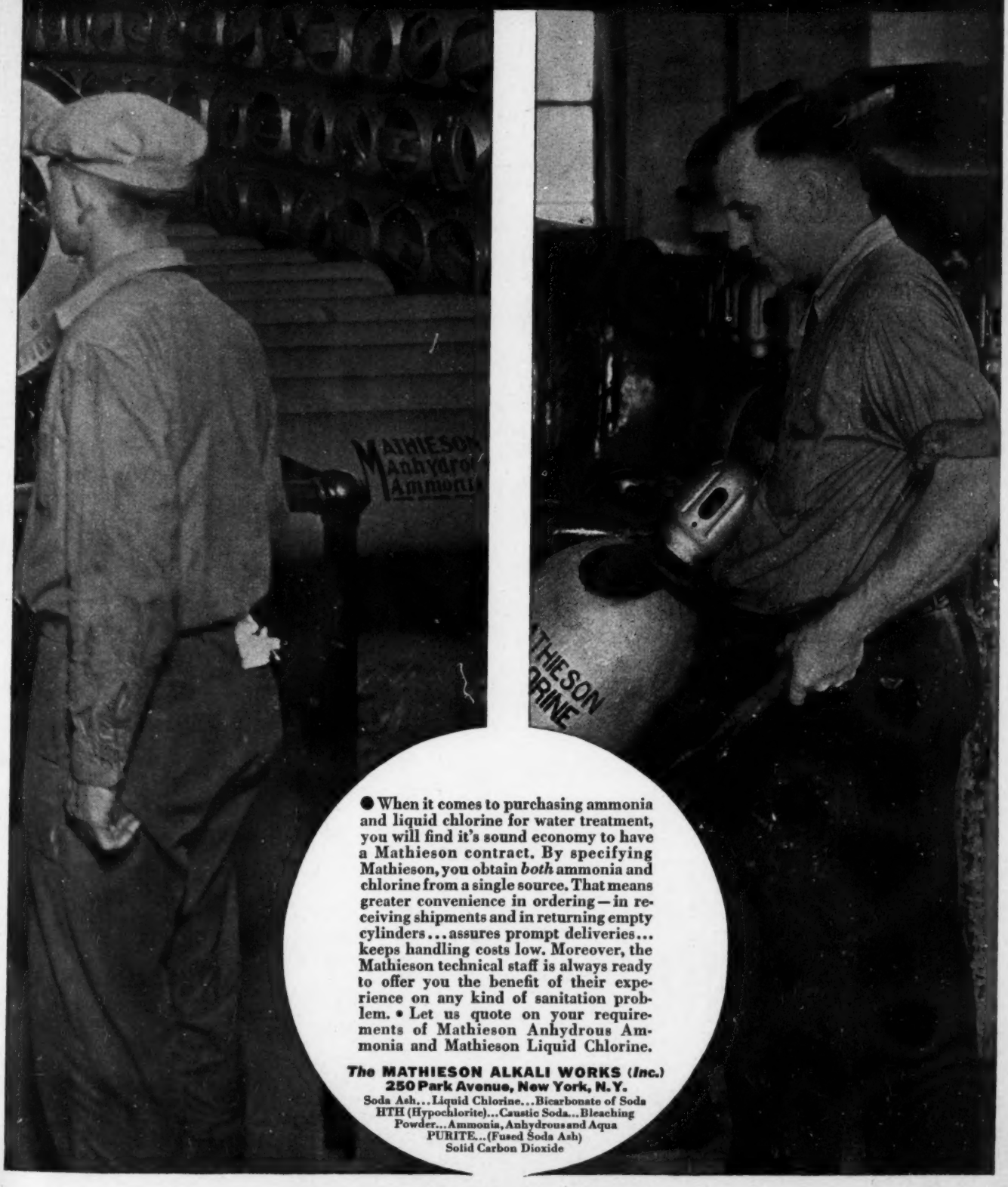

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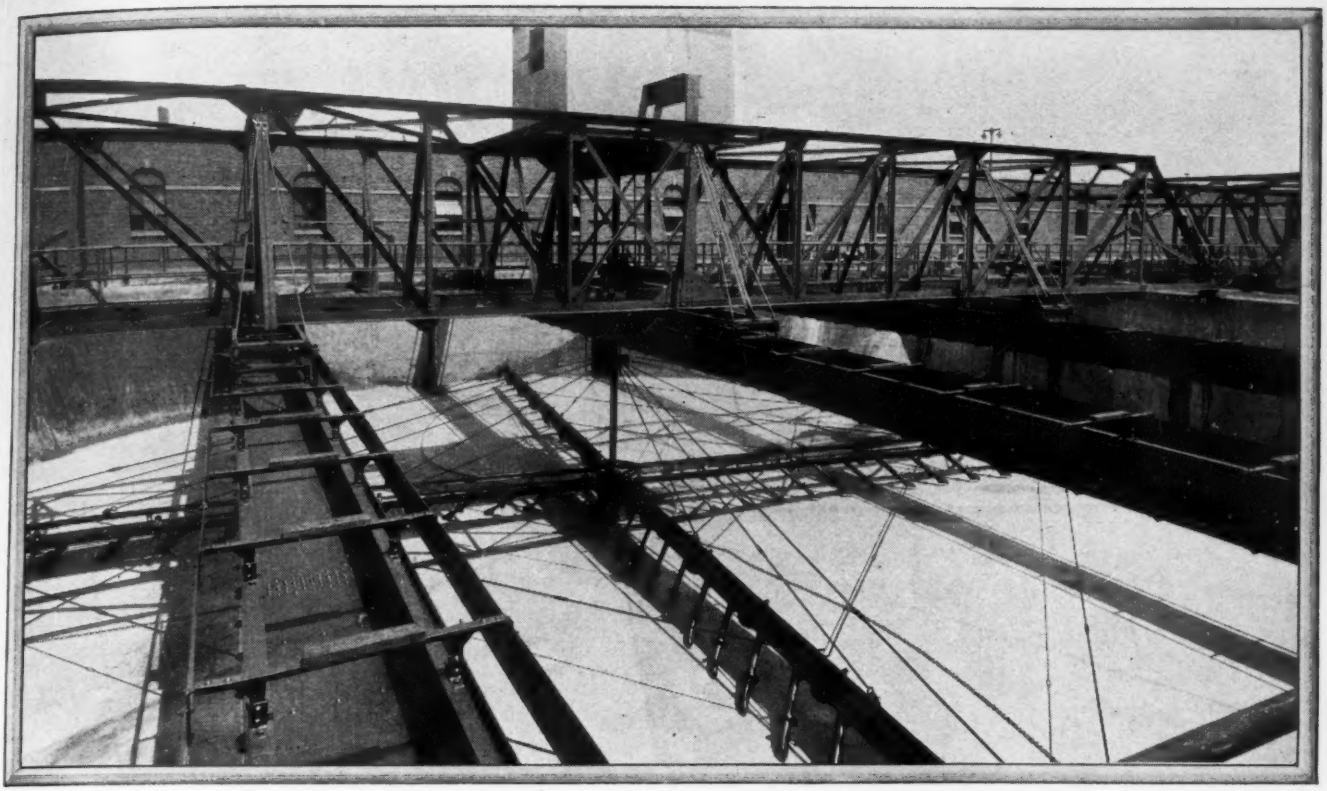

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The Tow-Bro Clarifier is a new unit of Sanitation Equipment, built by the Chain Belt Company, primarily for sludge removal from secondary settling tanks in activated sludge plants. It is also recommended for final settling ("humus") tanks in trickling filter type plants.

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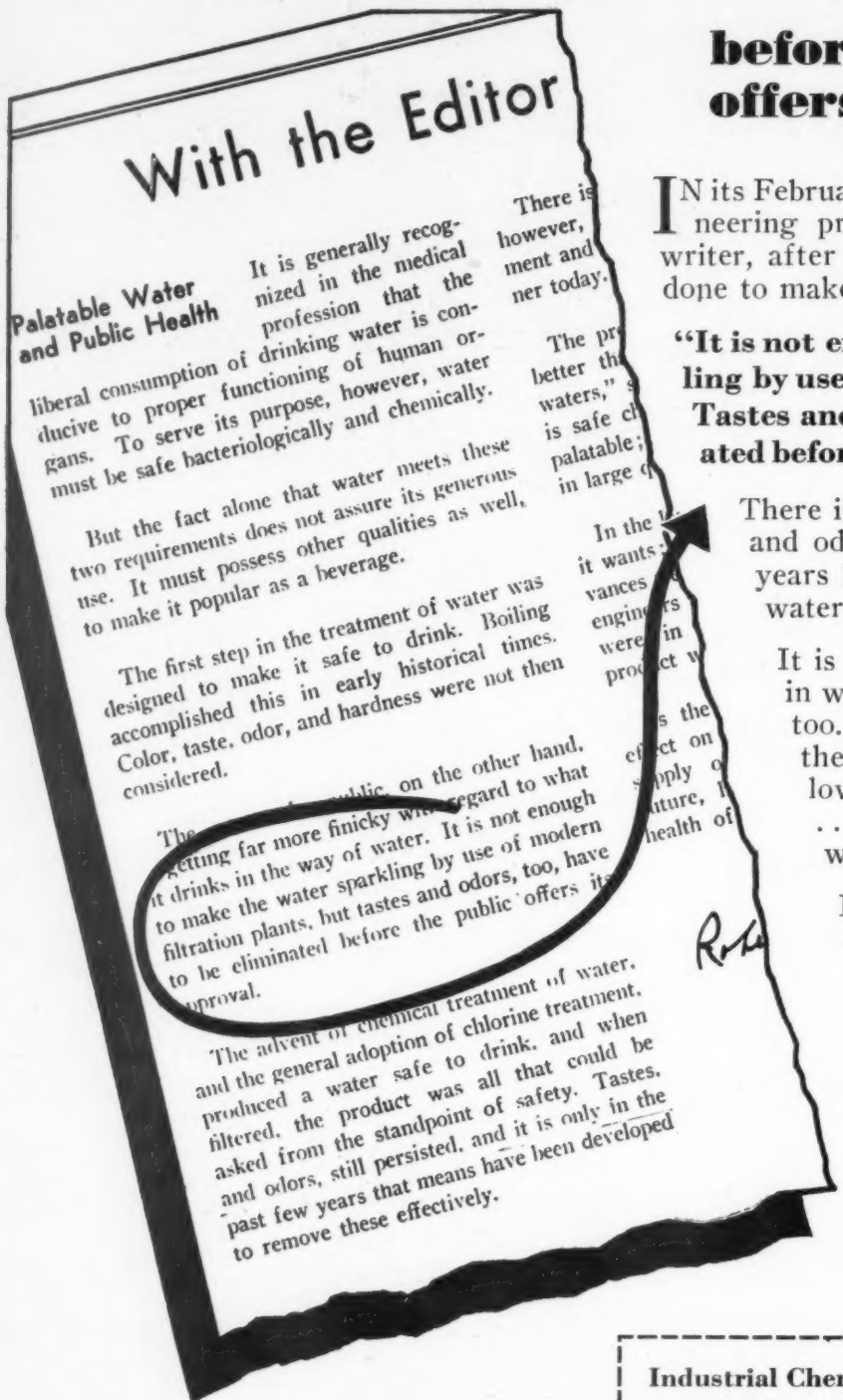
With the Editor
Palatable Water and Public Health
It is generally recognized in the medical profession that the liberal consumption of drinking water is conducive to proper functioning of human organs. To serve its purpose, however, water must be safe bacteriologically and chemically.
But the fact alone that water meets these two requirements does not assure its generous use. It must possess other qualities as well, to make it popular as a beverage.
The first step in the treatment of water was designed to make it safe to drink. Boiling accomplished this in early historical times. Color, taste, odor, and hardness were not then considered.
getting far more finicky with regard to what it drinks in the way of water. It is not enough to make the water sparkling by use of modern filtration plants, but tastes and odors, too, have to be eliminated before the public offers its approval.
The advent of chemical treatment of water, and the general adoption of chlorine treatment, produced a water safe to drink, and when filtered, the product was all that could be asked from the standpoint of safety. Tastes and odors, still persisted, and it is only in the past few years that means have been developed to remove these effectively.

before the public offers its approval

IN its February 10th issue, Water Works Engineering printed this timely editorial. The writer, after briefly reviewing what has been done to make drinking water *safe*, goes on:

"It is not enough to make the water sparkling by use of modern filtration plants.... Tastes and odors, too, have to be eliminated before the public offers its approval."

There is an effective treatment for tastes and odors. Its success in the past two years has been one of the highlights of water supply history.

It is easy to apply, involves no change in water plant design. It is inexpensive too. There are cases on record where the cost of this treatment has been as low as 30c per million gallons. And . . . it is enthusiastically endorsed by water works authorities.

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WATER WORKS AND SEWERAGE

JUNE 1932

VOL. 79 No. 6

A GILLETTE PUBLICATION

SOME PRACTICAL ASPECTS OF SEWAGE SCREENINGS INCINERATION

By W. W. YOUNG, C. E.

Consulting Engineer, New York City

THE Westchester County Sanitary Sewer Commission has installed in all its large sewage treatment plants in the southern part of Westchester County, New York, apparatus for disposing by incineration of all the sewage screenings from both coarse and fine screens.

Conspicuous among these plants of the Sanitary Commission is that at South Yonkers on the city line of New York City. This plant serves the Bronx Valley, Upper Bronx Valley, Hutchinson and South Yonkers county sewer districts, which have a present tributary population of about 200,000 and an ultimately expected tributary population of upwards of 1,000,000. The plant, situated on the bank of the Hudson, discharges its effluent into the channel under some 50 ft. of depth where the rapid flow secures prompt and efficient diffusion. The present average daily sewage flow is about 14 million gallons. The plant provides: Brief sedimentation with pre-chlorination for odor control; grit removal and washing. Coarse screening with automatic and secondary screens. Fine screening with mechanical dewatering of solids and odorless incineration of screenings. Effluent disinfection by liquid chlorine under laboratory control. Disposal by remote diffusion in deep swift tidal salt water.

The plant is located in a high class residential section and within 10 or 20 rods of two large, high class, private educational institutions. (See Front Cover Illustration.) Certain local conditions required that the chimney should not extend more than 30 ft. above the original surface of the ground. It therefore becomes necessary to assure the absence of nuisance from smoke or odors due to the operation of the incinerators, in fact the production or dissemination of odors of whatever nature must be continuously avoided at any cost. Prechlorination is the most important odor control and metal tarnishing prevention measure for the sewage proper. However, all parts of the channels are kept free from deposits and clean housekeeping methods are applied to the plant as a whole.

The intent of the present treatment of sewage at this plant is to remove all matters offensive to sight or not readily yielding to complete sterilization and disposal by dilution, and to utilize to the fullest the very extensive dilution offered by the swift currents and refreshing tidal prisms and flows at the points of outfall.

In this plant an important task, then, is the collection and removal of screenings and their rapid, inoffensive, and complete disposal. Many proposals have been made to the commission for installing apparatus for recovery of byproducts or for making fertilizer, industrial alcohol, etc. None of these yet appear sufficiently attractive for practical consideration on a commercial scale throughout the year; although curing, composting, and use of screenings on a limited scale has been successful for certain purposes in other instances.

The mechanical features of the plant include mill building cranes, mechanically cleaned trash racks, a complete grit washing system with ejectors, disc type fine screens (Fig. 1) delivering screenings by belt conveyors and through roll presses to two incinerators with appurtenances. Other equipment includes an air compressor, standby ejectors for handling the screenings, auxiliary salt water pumps, electric drive on all sluice gate valves, air preheaters, etc. Several new and effec-

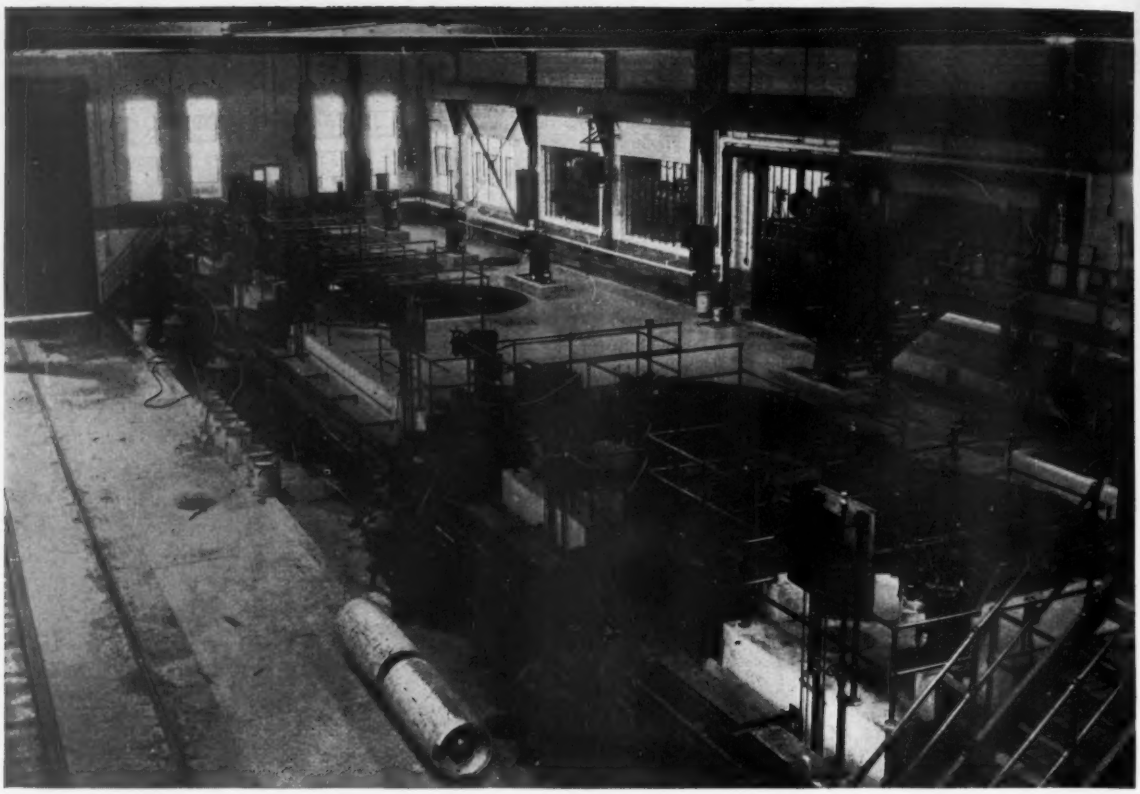

Fig. 1.—Fine Screen Room of Treatment works at South Yonkers, Westchester County, N. Y.

tive interpretations of old ideas appear in the mechanical devices in the plant.

Incineration thus far seems to offer the most economical, least space consuming and most inoffensive method of fine screenings disposal. Studies, including plant size experiments, are being made of the feasibility of incineration of the raw grit. It appears that some changes would have to be made to the incinerators to secure proper presentation to the flame. The clinker formed by the grit is readily removed and handled, somewhat resembling pumice stone in texture.

[At Milwaukee considerable progress is being made in the incineration of grit and screenings. See report of Central States Sewage Wks. Assn., in July issue.—EDITOR.]

Two Types of Incinerators Used

Two different kinds of incinerators, already widely and successfully used in garbage disposal were installed. One being of the water-jacket furnace type (Fig. 2) and the other of the fire-brick furnace type (Fig. 3). The overall dimensions of the former are approximately 23 ft. long by 8 ft. wide by 9 ft. high, and of the latter 25 ft. long by 8 ft. wide by 9 ft. high. Each has a rated capacity of one ton of screenings per hour when the water content of the screenings is between the limits of 70 per cent and 95 per cent. This capacity has been somewhat exceeded in the test runs. Fuel oil is used as the main source of heat and because the chimney is extremely low (30 ft.) both incincerators are required to work under a handicap of a light natural draft.

A number of modifications have been made and experience leads to the belief that more radical departures in certain features of these incinerators might be advantageous.

The burners are of the atomizing type. There is one auxiliary burner for each incinerator so located that its flame may be applied to the flow of gasses at a point beyond the hearth on which the screenings are burned thus insuring destruction of odors should combustion have been incomplete or temperatures deficient. Air

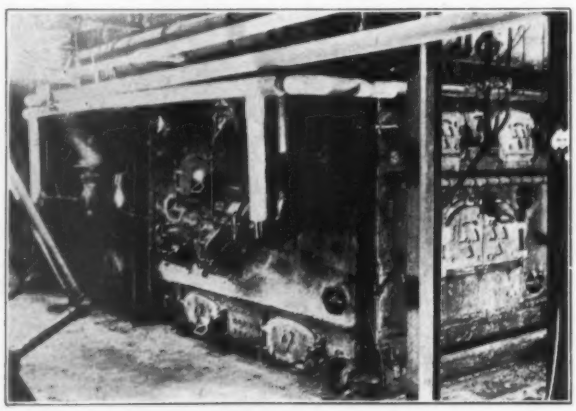

Fig. 2.—Water Jacket Furnace Incinerator, South Yonkers Plant, Westchester County, N. Y.

Fig. 3a.—Front of Fire-Brick Incinerator

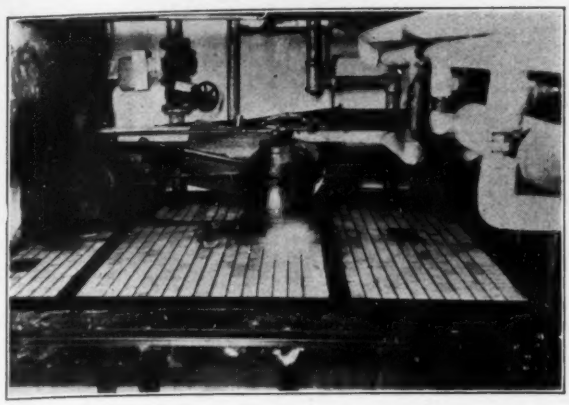

Fig. 3b.—Burner End of Fire-Brick Incinerator

ducts, fans and heat recovery apparatus of the regenerative type permit either hot or cold air to be supplied for combustion.

The gasses from both incinerators pass into a common flue, and dampers provide for sending the hot gasses either through the regenerator and thence to the stack or direct to the stack, as desired. A "Twelve-point" recording type of pyrometer provides a continuous chart of temperatures throughout the system.

The materials are brought from the coarse screens and the fine screens to bins over each incinerator from which they pass through gates into the charging holes in the top of the furnaces (Fig. 4). Screenings are in excess of ½ ton per million gallons of sewage. The ratio varies throughout the week and is increased with high flows. The water content varies considerably, during the day as well as from season to season. At the screens the water content varies from 85 per cent to 95 per cent with an average value in the neighborhood of 90 per cent. Auxiliary mechanical squeezing apparatus in the plant reduces the water content to between 75 per cent and 85 per cent with an average near 80 per cent. The material is fairly typical of screenings from ordinary domestic sewage. Except for spent grain, due to constitutional irregularties, other industrial wastes are almost absent. Tests have indicated that the screenings when dried have a heating value of 6,000 to 7,000 B.T.U. per pound of dried material and an ash residue of but a small fraction the dried weight.

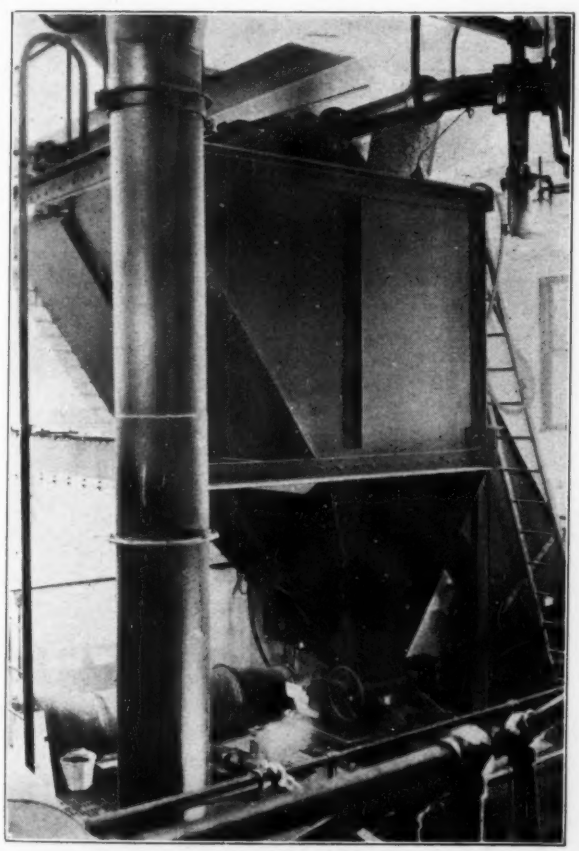

Fig. 4a.—Screenings Storage Bin, Located on Top of Water Jacket Incinerator

The capacities of the incineration furnaces are but slightly influenced by the normal variations in moisture content of the material burned, the fuel consumption is, however, noticeably more with the wetter material. The rated capacities (one ton per hour) for each incinerator are readily met but under average conditions ease of operation results when operating at a slightly lower figure than one ton per hour.

Fuel Consumption

Representative tests on the *fire-brick furnace* type incinerator show a consumption of No. 6 fuel-oil of approximately 25 gallons per ton of screenings when the water content of the screenings does not exceed 80 per cent and when using cold air for combustion. Preheated air reduces this consumption of fuel as does also the reduction in the water content of the screenings.

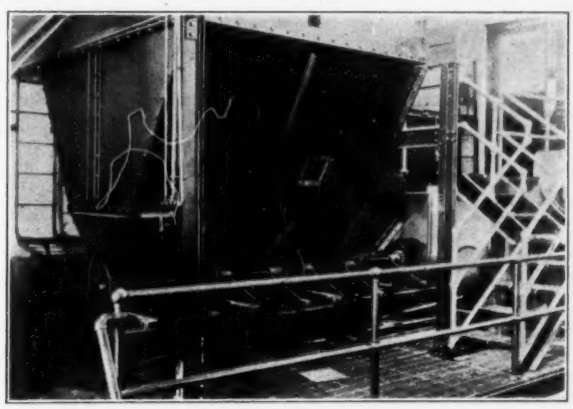

Fig. 4b.—Screenings Storage Bin, Located on Top of Fire-Brick Incinerator

A higher fuel consumption has been noted for the *water-jacket type* of incinerator. To some extent this may be offset by the fact that steam generated in this type incinerator is available for auxiliary purposes, such as heating the building.

The operating force consists of a stoker and a helper, the duties of the latter being largely to assist in charging the furnaces, caring for auxiliary apparatus and cleaning up while the former does the stoking and regulates the burners. It has been found that, with competent personnel, there is no occasion to have odors or smoke from the chimney even with widely varying water content in the material burned or changing atmospheric conditions, the gasses leaving the top of the chimney being perfectly clear.

Operating Factors and Deterioration

The important factors in proper operation appear to be, *intelligent stoking*, provision of an *ample quantity of air* and maintenance of a temperature in the combustion chamber just beyond the incinerator which at all times will be above a minimum of approximately 1400° F.

To maintain this temperature, it has been found advisable to keep the average temperature several hundred degrees higher than the minimum stipulated. This precaution is necessary to offset the inrush of cold air when the doors are opened for stoking, which results in a sudden dip in the pyrometer chart. The same temporary temperature drop occurs with each dumping of a fresh charge of pressed screenings on the hearth. The ash is a light yellow, finely divided material resembling thoroughly burned wood or paper ash and no difficulty has been experienced in securing complete combustion.

Operations, which have now been going on for nearly a year, do not yet indicate the life to be expected from the various parts of the incinerators. Some spalling of the fire-brick has taken place around door and burner openings and the lower sides of arches, but not to an extent which would indicate when replacement will be necessary, nor has the length of life of the plates and tubes in the water jacket type furnace been indicated, and it does not appear that either the wet type of material handled or the high localized temperatures caused by the oil flames have been particularly destructive.

Conclusions

The general results of operations to date are such as to show that disposal of sewage screenings and material of this nature at a reasonable cost* and without nuisance is entirely practicable by incineration. The character of the sewage will be somewhat different at each of the other Westchester County plants so that minor modifications of the auxiliary machinery are being provided to meet these variations and to facilitate the operations but the general features of the incinerator units will have much in common.

While conclusions were not reached in time to affect the immediate design, it would be improper to close without a mention of investigation of promising experiments and operations with rotary incinerators and, more particularly of a hammer-mill spray-drying process which was tried out in commercial sized experiments by the Industrial Associates, Inc., of New York, under our observations. Here the screenings both coarse and fine, just as they came from the screens, were atomized and fine-sprayed in a manner similar to the process of powdered milk production, to fall in readily handleable flakes to the floor of the heated drying chamber.

The South Yonkers Plant was detailed, and its plans, construction and test operation supervised by J. W. Van Denburg, Project Engineer on the engineering staff of the writer. This article has been prepared in cooperation with W. R. Schreiner, Chemist and Bacteriologist in Charge of Operations, at Westchester County Sewage Disposal Plants.

*Note: At this writing the author feels that operating costs may be subject to revision as the result of improvements gradually being installed. In a later article operation costs will be discussed.—Editor.

▼

Water Treatment at Columbus, O.

The recently issued report of the Division of Water of Columbus, O., of which C. B. Hoover is superintendent, contains the following note on the treatment of water in 1931:

The raw water supply consists of that impounded by the Griggs and O'Shaugnessy reservoirs (1,487,000,000 gals. and 5,400,000,000 gals. respectively) located on the Scioto river 5 miles and 15 miles respectively above the raw water intake at the main pumping station.

During the year 1930, the withdrawal of water from the upper reservoir began on July 1st and continued to Feb. 20, 1931, at which time the loss in storage amounted to 3,800,000,000 gals. On Feb. 20, 1931, there was sufficient run-off to fill the upper reservoir and from that time to the end of the year 1931, there was practically no loss of storage.

The hardness of the raw water during the year averaged 15.8 grains per gallon and varied from 21.5 grains in January to 10.8 grains in September. The hardness was reduced to an average of 5.1 grains by the lime-soda ash softening treatment which was effected by the use of 7778 tons of lime at an average price of $5.50 per ton and 3165 tons of soda ash at an average price of $22.59 per ton.

The amount of alum required to clarify the water during the past years has been considerably below the average for the past ten years, the actual amounts being 1.1 grains per gallon for both 1930 and 1931 as against an average of 2.0 grains for the ten year period.

A lower average turbidity naturally explains the lower alum dosage, the average turbidity for 1931 being 64 parts per million as against 88 parts as a ten year average.

The total cost of lime, soda ash, and alum used during the year 1931 was $123,384.00, which is an average cost of $0.0107 per 1000 gals. or $0.08 per 1,000 cu. ft.

Bacterial purification of the raw water in 1931 is indicated by the average raw water count of 2180 per cc and the average tap water count of 7 per cc. The B Coli index of the raw water for the year 1931 was 397, whereas the tap water had a B Coli index of 0.6.

▼

Sewage Works and Cast Iron Pipe

In the *U. S. Piper** for June, 1932, there appears an impressive feature article, giving a clean cut and brief description of what is to be the largest sewage treatment works of the activated sludge type in the world. That plant is now under construction by the city of New York on Wards' Island at Hell Gate on the East River. It will care for 180 million gallons of sewage per day and is being constructed at a cost of $30,000,000 to serve a population of 1,350,000 people.

That cast iron pipe is assuming an important place in sewerage construction, as well as in water works, is evidenced by the statement contained in the *Piper* which, having impressed this writer, is being stated here for the purpose of indicating the immensity of the Wards' Island project, and the importance which sewerage construction projects will have in affording employment in mills producing cast iron pipe and other materials used in the sewerage field.

The sewage enters and leaves the treatment works through cast iron pipes. The largest pipes used are of 5 ft. and 6 in. diameter and the smallest is 4 in. The main compressed- air line is of 66 in. pipe. The smallest air line to the Norton air diffusors is of 6 in. cast iron. The Venturi meters used to measure the sewage flow to the aeration tanks are 40 in. in diameter.

The *Piper* reports that 2,353 tons of bell and spigot pipe and 147 tons of flanged pipe is being used. In addition 715 tons of special casting and 75 tons of flanged fittings will be used. The total amount of pipe and fittings involved in the project can perhaps best be appreciated when it is expressed in terms of the number of pieces shipped. To deliver the order a total of 150 carloads of pipe and fittings will be shipped and will embrace the delivery of 11,000 pieces in all.

*House organ of the U. S. Cast Iron Pipe Co.

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor
Physical Chemist, Bureau of Engineering, Chicago, Ill.

AERATION

Part 1. The Effect of Films at the Water-Gas Interface

AERATION as a means of improving the quality of potable water has been used for many years. A fairly extensive list of filtration plants in the United States shows that approximately 20 per cent of the plants have provisions for aeration. If this ratio holds for all the plants there must be about 400 water supplies equipped for aerating the water.

At one time aeration was almost the only means of improving the taste and odor of water, but now there are other means of doing this, and aeration must prove that it is the most economical process if it is to continue being used. Aeration, of course, is not confined to taste and odor removal, and its use is fully justified in some instances where it adds nothing to the palatableness of the water. It is almost essential to add oxygen to water deficient in oxygen. The addition of oxygen to water is sometimes necessary for iron and manganese removal in most waters where these constituents have to be removed. It frequently is economical to reduce the carbon dioxide content of water by aeration provided the CO_2 content is above 10 parts per million.

Fundamentals of Aeration Not Well Understood.—The extensive use of aeration in public water supplies justifies giving more consideration to the theory of aeration than has been done in the past and to date no theory has been advanced and properly developed. For gaseous compounds easy to measure in the laboratory, such as carbon dioxide and hydrogen sulfide, one may predict with a fair degree of accuracy the amount of these materials a given aeration system will remove from the water. This prediction, however, is based upon past performance at other places and aside from these two gases, little is known about the removal of dissolved gases from water.

The theory of absorption of gases by water is better understood than the release of gases from solution, and while the release is referred to as negative absorption there is no specific proof that the rate of release is the same as the rate of absorption. It has been shown[1] that the rate of gas absorption is influenced greatest by the films of liquid and gas at the liquid-gas interface, and it seems reasonable to assume that the release of gases from water is also influenced greatest by these films, especially by the liquid film. The variation in the thickness of the films makes it difficult to use a formula for estimating the absorption or release of gases by or from solutions. While formulas for the absorption of gases have been developed which give a fair degree of accuracy, there is no definite assurance that they will be accurate for computing the release of gases from water.

Films at the Water-Gas Interface.—When a water-gas surface is formed it is assumed that the water molecules at the gas surface and the gas molecules at the water surface become oriented into a certain definite position in contrast to their free movement within the water or within the gas. In other words, there exists

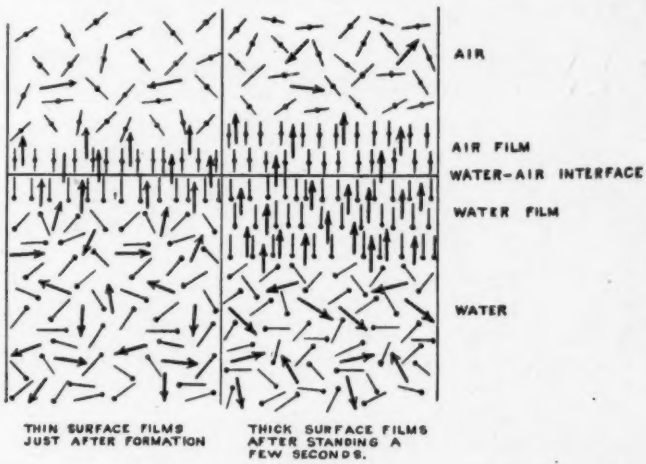

Fig. 1.—Diagram Representing the Films on the Water-Air Interface

on the gas side of the interface a layer of gas in which motion by convection is slight, and similarly on the water side of the interface there exists a layer of water which is nearly free from mixing with the water beneath it by convection. The transfer of gas molecules through these layers must be by diffusion, which is a fairly slow process. Figure 1 is given to illustrate the two films at the water-air interface. The arrows indicate the dissolved gas molecules which are to be removed by aeration and this illustration will be explained more fully in another paragraph.

Thickness of the Films.—If the film theory is correct, and there is good evidence that it is, it is natural to expect that the films will be very thin when first formed and become considerably thicker shortly after formation. The films shown on the left side of the drawing in Fig. 1 represent the thin films first formed, and the thicker ones on the right represent the films after a lapse of

perhaps one or more seconds. The relative thicknesses may vary considerably from that shown. The film thickness for water at the water-gas interface has been estimated to be from .00026 to .17 centimeter, depending upon the agitation given the water. The thin film is for a drop of water falling, and the thick film is for water at rest. Even though the average thickness of the film around a falling drop of water is estimated to be only .00026 centimeter, this film may have built up from one which at first was only one molecule in thickness. If the film is .00026 centimeter in thickness, it is evident that it is a number of molecules in thickness.

Gas Molecules Passing Through Water-Air Films.—The passage of the gas molecules through the water and air films is represented in Fig. 1. When the films first form it is believed that the dissolved gas molecules will pass through the thin films more easily than through the thicker films. The arrow symbols for dissolved gas molecules must not be construed as representing the shape of the molecules or their number in comparison to the water molecules, but they are to indicate the direction in which the molecules are traveling. Likewise the representation of the other molecules do not give their shape, but show whether they are moving freely in all directions or are in a fixed position at the water-air surface. When a dissolved gas molecule, which has been traveling in various directions within the water due to its own force and also the motion of the water, starts to pass through the liquid film, it is believed that its motion is lessened very materially and that it must pass through both the water and the gas films at velocity very much less than it has been traveling within the solution. The water and gas films remain thin for such a very short time it is impossible for all the water within the drop to come in close contact with the films before they become thicker, unless the water is broken up into very minute drops which is not always practical in the aeration of water.

Thickness of the Films Greatly Influenced by the Agitation Given the Water.—The thickness of the films is influenced by the agitation given to the water, and a rising spray and the falling drop is probably the maximum agitation which is practical to produce. Whitman, Long and Wang[2] estimated the film thickness of a falling drop weighing 0.09 gram to be .00026 centimeter. The drops fell a distance of approximately 1.7 ft. This is very much less than the figure of .0011 centimeter obtained by Adeney and Becker[3] for bubbles of oxygen, nitrogen, and air, ascending in water. Ledig and Weaver[4], using smaller bubbles of carbon dioxide, calculated the film thickness to be .0008 centimeter. Table I, most of which is taken from Lewis and Whitman[1], shows the effect of agitation upon film thickness of liquids as estimated by several authors. Stirring at 1,000 revolutions per minute is very rapid motion, yet the film formed is estimated by Becker to be .0045 centimeter, or approximately 17 times the computed thickness of the water film around a falling drop as estimated by Whitman, Long and Wang[2]. Should these authors be considerably in error in their estimates it is evident that the thickness of the films at the water-air interface varies considerably under different conditions.

Falling Drops Produce Thinnest Films.—Table I shows that the falling drop produces the thinnest water film at the water-gas interface as determined by the rate of gas absorption. This probably is due to the very rapid mixing of the water within the drop as it is falling and to the friction through the gas. It seems that this condition would be most ideal for the release of dissolved gases from water, for in addition to the very thin water film it is bringing the drop constantly and rapidly into contact with air that contains little or practically none of

TABLE I—EFFECT OF AGITATION UPON FILM THICKNESS

R. P. M.	Investigator	Gas	k_L	Film Thickness Centimeters
At rest	Adeney and Becker...	O_2, N_2	0.4	0.17
60	Davis	O_2	3.3	0.020
150	Becker	O_2, N_2	5	0.013
250	Bohr	CO_2	7.5	0.009
1000	Becker	O_2 N_2	15	0.0045
*Bubbles rising	Adeney and Becker...	O_2, N_2	60	0.0011
*Drops falling	Whitman, Long and Wang	CO_2	260	0.00026

*Not given in the original table.

The (k_L) in the table is the rate of absorption coefficient through the water film at the interface.

the dissolved gas. It is the rapid motion of the water within the drop and not diffusion that brings about rapid equalization of the concentration of the dissolved gas throughout the drop and expulsion of much of it.

The problem of removing dissolved gases from water by aeration is largely a problem of producing a very large water-air surface, and to keep the water in such a state of motion that all of the water comes in close contact with the air surface within a very short time. The motion of the water should be such that only thin films are produced and maintained. Even though these conditions may be met in a fairly satisfactory manner by the use of sprays to break up the water into small drops, there are other factors which influence the rate at which the dissolved gas will escape from the water. Temperature has some effect—the higher the temperature more rapid will be the rate of escape of the gas. The solubility of the gas and the concentration of the gas in the water materially affect the rate at which the gas will be released from the water. The vapor pressure of the

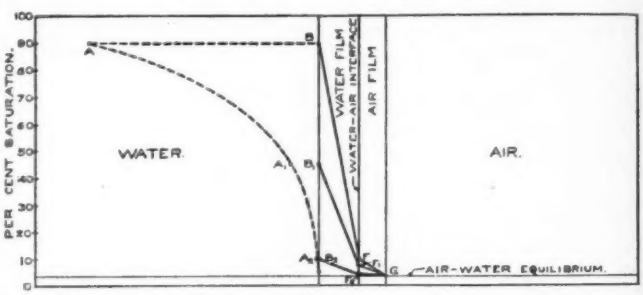

Fig. 2—Diagram Representing the Release of Dissolved Gases from Water

compound also is a very important factor. This will be discussed in a second article on Aeration.*

Illustration of the Escape of Dissolved Gases Through Surface Films.—The escape of gas from water may be illustrated by the diagram in Fig. 2. The bottom horizontal line represents zero saturation, and the top line represents 100 per cent saturation. One hundred per cent saturation may be anything from a few parts per million for very insoluble gases to several thousand or more parts per million for very soluble gases. When the water has been brought to complete equilibrium with the atmosphere the concentration of the dissolved gas in the water will be reduced to the horizontal line passing through C and G in Fig. 2, which for most dissolved gases will be practically on the zero line. Assuming that there is rapid replacement of the air, such as is the case for a drop of water falling, the escaping gas molecules will pass into the air which has an equilibrium with the water nearly on the horizontal line passing through C

*To appear in the July issue of Water Works and Sewerage.—Editor.

and G. Assume that the water is 90 per cent saturated, then the concentration of the gas drops from the 90 per cent line which passes through B on the water side of the liquid film to F at the interface, and to approximately G on the air side of the gas film. The line of drop in concentration of the dissolved gas from B to F is shown straight, and while it may not be a straight line this is not of consequence for the purpose of illustration. Should the dissolved gas pass through the air film more easily than through an equal thickness of water film there will be a break in the line from B to G at F in the direction indicated by the line.

Many gases never occur in waters used for public supplies to the extent that the water approaches saturation with the gas, and instead of the per cent saturation being at the point B on the vertical line through BC it may be at B_1, B_2, or some other point along the line. The lower the concentration, the less will be the forces tending to send the gas molecules through the surface films. The force for some particular gas at 90 per cent saturation may be represented by the line AB. Then the force at B_1 or B_2 for this gas will be A_1B_1 or A_2B_2. The line AC may not be curved as much as is shown. In fact it may curve only slightly or not at all for some gases. The diagram is not based upon specific figures for some particular gas, and the distance from A to B does not represent any certain amount of energy tending to force the dissolved gas molecules into the air. It is intended to represent a force at the 90 per cent saturation point which varies for each particular gas. It may be a thousand times greater for a highly soluble gas than for one not highly soluble. Reference to the saturation point of a gas means the equilibrium of the water in contact with an atmosphere of the gas in question.

Gases Which Require a High Percentage Saturation to Produce a Taste or Odor May Be Easily Removed by Aeration.—If it requires 20 to 25 per cent saturation of a gas to produce an odor or taste just noticeable, and the water happens to be 75 per cent saturated with the gas, there should be no difficulty in reducing the concentration below the odor or taste producing point with an efficient aerating system. Should 1 per cent saturation of a gas be the taste producing point, and the water is 10 per cent saturated with the gas, it probably will not be possible to entirely remove the taste or odor by the usual aerating systems. It is evident that any dissolved gas which produces an objectionable taste or odor in water can be reduced below the taste or odor producing point by prolonged aeration, but it may be very expensive to do so. This should not be construed as meaning the odor or taste from compounds that exist as a gas only slightly below the boiling point of water may be easily removed by aeration. It is doubtful if any compound which has a boiling point above about 25° C. may be economically removed from water by aeration. This will be discussed more fully in the next article.

Experiments on the Reduction of CO_2.—Experiments have been run on the reduction of CO_2 by dropping the water from various heights. The water was carbonated to the desired point and allowed to drop into a beaker partially filled with kerosene oil to avoid releasing the CO_2 after the drops strike the liquid. By collecting under oil it is believed that nearly all the reduction in CO_2 took place while the drop was forming and while it was falling. It may be impossible to avoid some reduction due to the splash in oil, but it should be very much less than if the drops fell into water. By releasing the drops very rapidly the time of formation of the drops was reduced to a minimum.

The tests were run with drops released at rates of 60, 100, 200, and 300 per minute. The time for the formation of the drops was 1.0 second at 60 per minute, 0.6 second at 100 per minute, 0.3 second at 200 per minute, and 0.2 second at 300 per minute. At a rate of 100 drops per minute the volume of each drop was 0.085 cc., and at a rate of 200 drops per minute the volume was 0.09 c.c. It was not possible to accurately count the drops at a rate of 300 per minute so as to obtain the exact size of each drop, but they are believed to be slightly larger than the drops at the rate of 200 per minute. Tables II, III, and IV, give the results of three typical tests.

The data in Tables II and III are plotted in Fig. 3 and 4. The horizontal ordinate in Fig. 3 is the drop in feet, and in Fig. 4 it is time in seconds. The time shown is computed without taking into consideration the friction through the air. There probably is not very much of an error up to three or four feet drop, but the error may be considerable for a drop of 12 feet. The actual reduction of CO_2 in parts per million and the percentage reductions are plotted in Figs. 3 and 4. Except for the first part of the lines, the curves in Fig. 3 plotted with height of fall as one of the ordinates are nearly straight lines. The curves in Fig. 4 are not so straight. In attempting to interpret these lines it must be remembered

TABLE II—REDUCTION OF CO_2 FROM FALLING DROPS OF WATER

216 p.p.m. CO_2		200 drops per minute	Temperature 20° C.
Height which the drops fall Feet	P. P. M. CO_2	Time in seconds (Friction neglected)	Per cent reduction of CO_2
No aeration	216		
1	158	.25	27
2	145	.36	33
3	136	.43	37
4	127	.50	41
5	123	.56	43
6	114	.62	47

TABLE III—REDUCTION OF CO_2 FROM FALLING DROPS OF WATER

121 p.p.m. CO_2		300 drops per minute	Temperature 16° C.
Height which the drops fall Feet	P.P. M. CO_2	Time in seconds (Friction neglected)	Per cent reduction of CO_2
No aeration	121		
.08	108	.09	11
1	99	.25	18
2	95	.36	21.5
3	91	.43	25
4	88	.50	27
5	84	.56	31
6	79	.62	35
8	71	.71	41
10	64	.79	47
12	58	.86	52

TABLE IV—REDUCTION OF CO_2 FROM FALLING DROPS OF WATER

759 p. p. m. CO_2			Temperature 22° C. Time	
Height which the drops fall Feet	Drops per minute	P. P. M. CO_2	in seconds (Friction neglected)	Per cent reduction of CO_2
No aeration		759		
.08	300	669	.09	12
.08	60	568	.09	25
1	300	554	.25	27
2	300	539	.36	29
3	300	515	.43	32
4	300	484	.50	36
5	300	466	.56	38.6
6	300	436	.62	42.5
8	300	409	.71	46
8	100	321	.71	58
10	300	392	.79	48
12	300	374	.86	51

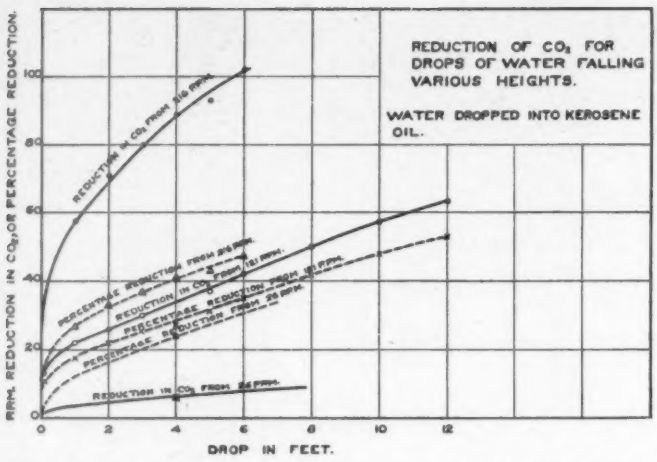
REDUCTION OF CO_2 FOR DROPS OF WATER FALLING VARIOUS HEIGHTS.
WATER DROPPED INTO KEROSENE OIL.
PPM. REDUCTION IN CO_2 OR PERCENTAGE REDUCTION
DROP IN FEET.

Fig. 3—Reduction of CO_2 for Drops of Water Falling Various Heights

that the time is computed without taking friction loss through the air into consideration. As the time shown in Fig. 4 increases from the zero line it becomes more and more in error. The parts of the curves to the left of the zero line represent the CO_2 which escapes while the drop is being formed.

The curving characteristics of the lines in Fig. 4 and one of the lines in Fig. 5 are not so easily explained, and perhaps the explanation which will be given is not entirely correct. It is evident that the rate of gas escape should increase with time while the drop is being formed, due to the surface area being increased. Immediately after the drop breaks loose and starts to fall the rate of gas escape decreases, due to an increase in the thickness of the films at the water-air interface. Then it appears that the rate again increases, probably due to the incresed velocity through the air causing the films to become thinner. A point should eventually be reached where the rate, when plotted against time, should decrease due to the decrease in concentration of the CO_2. This characteristic is shown by the curve plotted against time in Fig. 5.

The results given in Table IV and plotted in Fig. 5 are for water highly charged with CO_2, and would never be met with in a public water supply. The curve plotted against height of fall is similar to the curves in Fig. 3, and the curve plotted against time is similar to the curves in Fig. 4. The line plotted against time, however, shows curving characteristics more striking than in Fig. 4.

Large Water-Air Surface Essential for Efficient Aeration.—It is hoped that the importance of forming a very large water-air surface in aeration has been sufficiently stressed. This applies with equal importance both to spray and diffused air type aerators. For the aeration to be most effective the water should be broken up into fairly small drops if a spray type of aerator is used. Likewise, if a diffusion type is used the air bubbles should be broken up as small as possible. Water sprayed over trays of coke materially lengthens the time of fall, and if sprayed so that the films are very thin this type of aeration also should be very effective. The water trickling over the coke is constantly forming new surface films. The large reduction in CO_2 for the first foot of drop suggests that aeration could be made very much more effective than the mere spraying of water into the air or the bubbling of air through the water.

The compounds which may be removed from water by aeration will be discussed in a concurrent article.

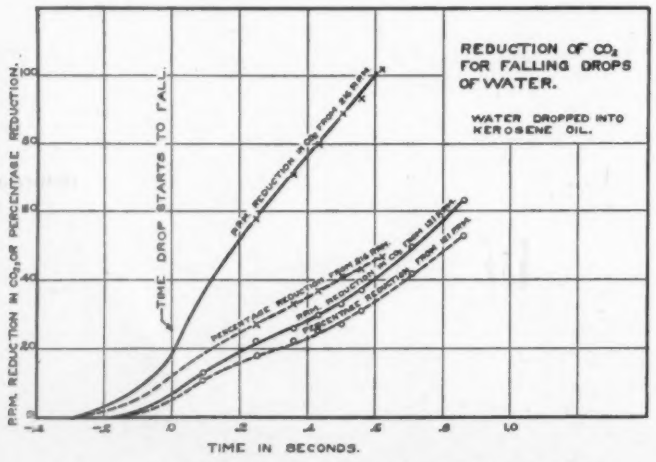
REDUCTION OF CO_2 FOR FALLING DROPS OF WATER.
WATER DROPPED INTO KEROSENE OIL.
TIME DROP STARTS TO FALL.
PPM. REDUCTION IN CO_2 OR PERCENTAGE REDUCTION
TIME IN SECONDS.

Fig. 4—Reduction of CO_2 for Falling Drops of Water

REFERENCES

1. Lewis, W. K., and Whitman, W. G. Principles of Gas Absorption. Ind. and Eng. Chem., 16: 1215-20, December, 1924.
2. Whitman, W. G., Long, L., Jr., and Wang, H. Y. Absorption of Gases by a Liquid Drop. Ind. and Eng. Chem., 18: 363-7, April, 1926.
3. Adeney, W. E., and Becker, H. G. Determination of the Rate of Solution of Atmospheric Nitrogen and Oxygen of Water. Phil. Mag., 38: 317-38, 1919.
4. Ledig, P. G., and Weaver, E. R. A Method for Studying the Rapid Absorption of Gases by Liquids. Jou. Am. Chem. Soc., 46: 650, 1924.

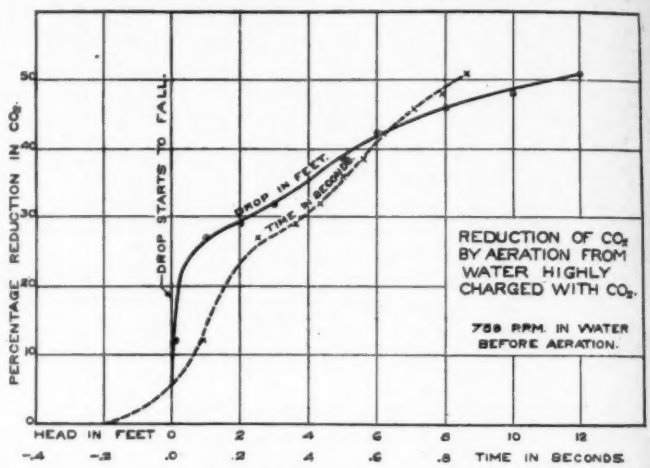
DROP STARTS TO FALL.
DROP IN FEET.
TIME IN SECONDS.
REDUCTION OF CO_2 BY AERATION FROM WATER HIGHLY CHARGED WITH CO_2.
750 PPM. IN WATER BEFORE AERATION.
PERCENTAGE REDUCTION IN CO_2
HEAD IN FEET
TIME IN SECONDS

Fig. 5—Reduction of CO_2 by Aeration from Water Highly Charged with CO_2

Tri-State Pollution Treaty Strikes a Snag

In WATER WORKS AND SEWERAGE for February, 1932, on page 60 reference was made to the proposed Tri-State Pollution Commission. It is the proposed body which would recommend the necessary steps to be pursued in cleaning up the tidal water ways of the metropolitan areas of Connecticut, New York and New Jersey that are adjacent to New York City.

The bill to establish and define the activities of the Tri-State Commission must be passed by the legislatures of the three states. The New York legislature has passed it. The Connecticut legislature does not meet this year.

The bill is now before the New Jersey legislature where in committee hearings it has met with opposition from the New Jersey Department of Health on the ground that the proposed compact would transfer control over sanitary matters in about one-third of the state from the Department to the Commissioners of the proposed Sanitary District. Harry E. Croft, Chief Engineer, and Clyde Potts, Consulting Engineer and member of the Board of Health, appeared against the bill with others.

LOSS OF VOLATILE MATTER BY DRYING SEWAGE SLUDGE BEFORE INCINERATION[1]

By W. RUDOLFS and WM. H. BAUMGARTNER

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THE loss of volatile matter is of considerable importance in the drying of sewage sludge. Economy in drying operations results from the use of high temperatures, and loss of volatile matter results in nuisances caused by quantities of smoky vapors formed of a penetrating disagreeable nature. If the dried sludge is subsequently incinerated there is a reduction in its heat value nearly in proportion to the prior reduction in the volatile matter. But formation of large amounts of the smoky material is probably the most objectionable factor of the two.

The experiments reported here were made to determine the optimum temperature for sludge drying from the standpoint of least volatile matter distilled off. Since dried solids might be exposed to the heat of the drier, samples of dried solids and wet sludge were used for experimentation.

The dried solids used were of varying volatile matter content in order to make the results applicable to the different types of sludge to be dried.

Method

Four different materials were used in carrying out the tests. Three of these sludges consisted of fresh solids of different volatile matter composition from which all moisture had been removed at 100°C.—105°C. The fourth sample was undigested sludge which was dried to 75.5 per cent moisture by heating it over a steam bath. The sludges were collected from the Plainfield, Trenton, and Ridgewood, N. J. sewage treatment plants.

Large samples of the sludges were pre-dried at 100-105°C. and small quantities taken for the tests. Uniform volumes of sample were used in order to obtain equal heat penetration because the latter is of great importance in insuring comparable results.

The weighed samples of sludge were heated in a muffle furnace, fitted with a variable resistance for adjusting the temperature. A thermocouple at the back of the furnace and a thermometer at the front were used for determining the temperatures. The samples were exposed to the temperature of the furnace for intervals of 10, 20 and 30 minutes at temperatures of 150° C. to 400° C. in 50° intervals.

In determining the loss of volatile matter by subjecting the dry solids to various temperatures calculations were made from the weight of the sample before and after heating. A different procedure was necessarily used in the case of the wet sludge because of the difficulty of separating volatile matter and moisture loss by weight. A control sample of sludge from the common batch was run with each set of samples placed in the furnace and moisture content and volatile matter content were determined through each control sample. By determining moisture content and volatile matter on the sample after removing it from the furnace, differences between the control sample and heated sample could be calculated as moisture and volatile matter lost.

[1]This is one contribution of a Journal series of papers from the New Jersey Department of Sewage Research.

Results

Loss of Volatile Matter from Dry Solids

The results of the heating of three samples of solids of varying volatile matter content are plotted in figure 1. The percentage lost of the total volatile matter is plotted against the temperature of heating. These solids were exposed to the several temperatures for 30 minutes in each case. There was a wide range in volatile matter content of the three samples viz. 49.6 per cent, 72 per cent and 79 per cent and whereas with increasing volatile content, a gradual increase in the amount of volatile matter *lost* was expected at the lower temperatures, the volatile matter lost was almost in direct proportion to the temperature rise from 100° C. Since the solids were dried at 100° C. this temperature was necessarily used as the base. At 150° C. there was a loss of about 10 per cent of the total volatile matter in two of the samples and 15 per cent in the sample containing 72 per cent volatile matter. The experimental results show that the loss of volatile matter progresses in the same proportion regardless of the amount of volatile matter in the solids initially, but no relationship was observed between the rate of volatile matter lost and the initial vola-

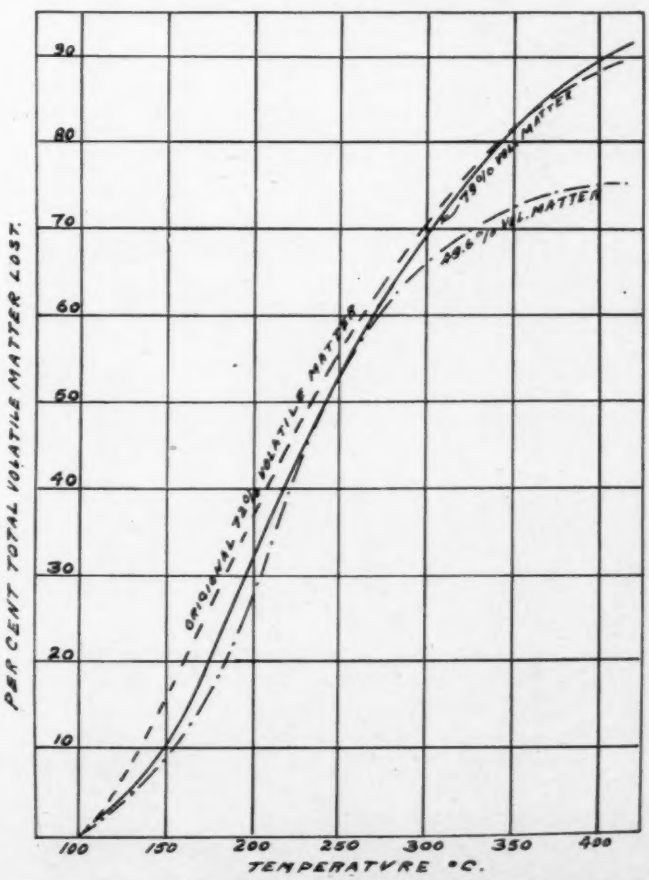

Fig. 1.—Loss of Volatile Matter From Solids of Different Volatile Matter Content at Various Temperatures. Exposure 30 min.

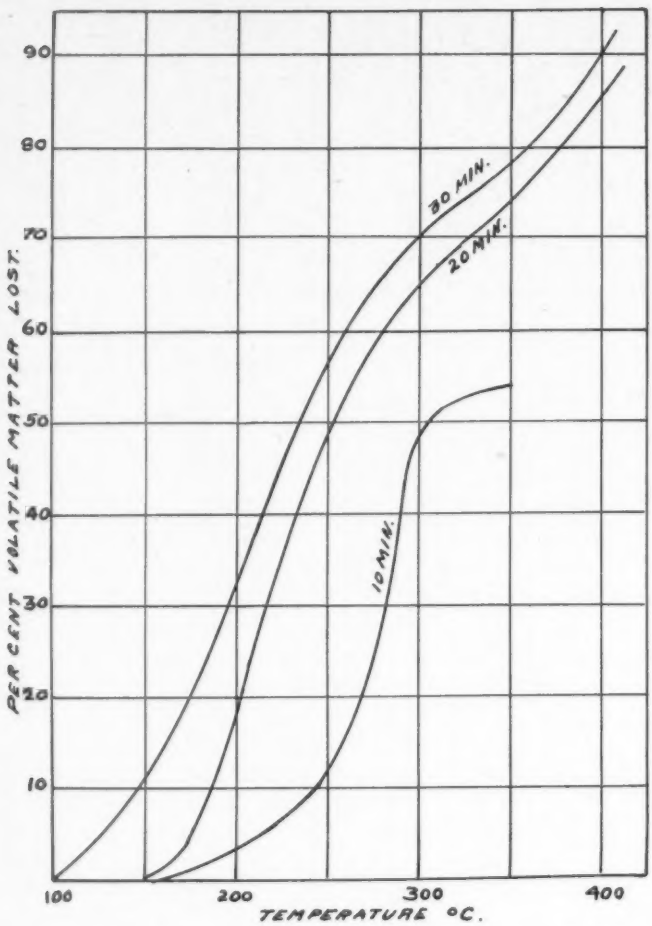

Fig. 2.—Loss of Volatile Matter From Dry Solids at Various Temperatures After Different Times of Exposure

tile matter content. Temperatures of heating were not increased above 400° C. because combustion took place at about this temperature. When the door of the furnace was opened at this temperature and air admitted the solids samples burned with a yellow flame.

The average results of heating the dried sludges containing 79 per cent volatile matter, at varying temperatures for 10, 20 and 30 minutes, is shown in Fig. 2. There is a lag in the loss of volatile matter at the lower temperatures from 100 to 250° C. when the sample is heated for 10 minutes. Evidently during this short exposure and low temperature the heat differential was not great enough to bring about rapid penetration to all parts of the sample. This lag becomes less noticeable when the time of exposure is increased until at 30 minutes the trend of volatiles lost appears as a nearly straight line. (See Fig. 2). The results indicate that 70 to 80 per cent of the volatiles are readily driven off at comparatively low temperatures if the time of exposure is lengthened. The major part of the volatiles present can be driven off at lower temperatures and increasing the temperatures merely increases that rate at which these volatiles are lost. The increase in temperature has no great effect on the proportion of total volatiles driven off when the time of heating is not a factor.

The results showing the relationship of the period of heating at different temperatures, to the loss of volatile matter, are plotted in Fig. 3. After an initial lag there was almost a constant rise in the amount of volatiles driven off at 200° C. At 300° C. and 350° C. there was a rapid rate of loss of volatile matter which did not decrease until from 70 to 80 per cent of the volatile matter had been lost and the curves for temperatures of 300° C. and 350° C. follow each other very closely.

Heating of Sludge

Fig. 4 illustrates the results of heating samples of wet sludge at different temperatures. The sludge contained 75 per cent of moisture and 78.5 per cent of volatile matter. The temperature of heating is plotted against the percentage of total volatile and moisture lost during 10, 20 and 30 minute periods of heating.

An examination of the 10 minute curves of volatile and moisture loss shows that less than 5 per cent volatile matter is lost at 400° C. even though 84 per cent of the moisture had been evaporated. At 350° C. approximately 2 per cent of the volatile was lost and 80 per cent of the moisture driven off and below this temperature the loss of volatile matter was negligible. [Correspondingly, Fig. 2 shows that when dried solids are heated for 10 minutes at 300° C., 50 per cent of the volatiles are driven off.] A greater amount of the moisture is driven off at any given temperature when the samples are heated for 20 minutes,—for instance, 2 per cent of the volatile is driven off at 250° C. with 20 minutes heating when 88 per cent of the moisture is lost.

The curves seem to demonstrate that regardless of the temperature of heating but little volatile is lost until 80 to 90 per cent of the moisture content of the sludge has been driven off. Since the sludge originally contained 75 per cent moisture it would contain roughly 37.5 per cent when 80 per cent of the moisture had been driven off. It appears therefore that 37.5 per cent moisture remaining in the sludge after heating is sufficient for preventing any appreciable loss of volatile solids even at drying temperatures of 400° C.—that is, provided that the residual moisture is equally distributed in the sludge to prevent loss of volatile matter from some portion overly dried because of unequal heating.

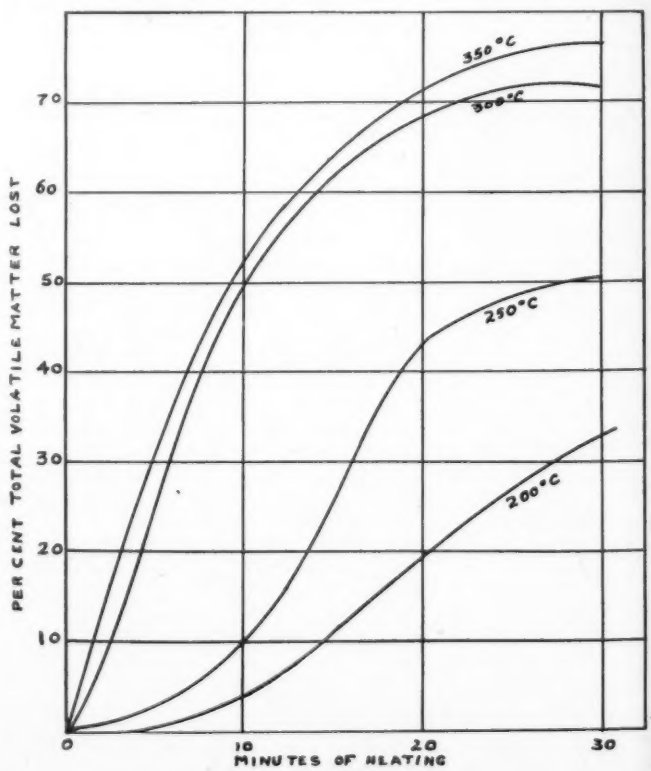

Fig. 3.—Relation of Volatile Matter Lost to Time of Exposure For Dry Solids

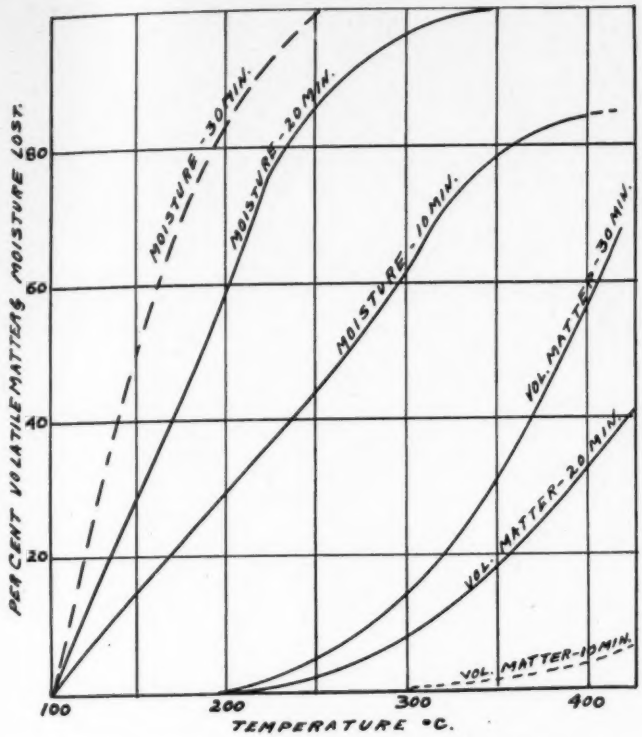

Fig. 4.—Loss of Moisture and Volatile Matter With Heating of Sludge at Various Temperatures

Discussion

Heating dried fresh solids caused a loss of volatile matter at temperatures from 150° C. to 400° C. When pre-dried (100° C.) solids were subjected to a temperature of 150° C. for 30 minutes 15 per cent of the volatile matter was driven off. At 200° C. the loss was 40 per cent and at 300° C. 70 per cent. This loss of volatile matter causes the release of large quantities of smoky material with a penetrating odor and reduces the heat value of the sludge subsequently incinerated. The loss of fuel value is of economic importance in incineration practice, but the creation of an odor nuisance is the most objectionable feature.

Solids of low volatile matter content lose volatile matter at very nearly the same *rate* as solids of a higher volatile matter content. The effect of the heat on these solids of different composition is approximately the same. Incidentally, such a rapid increase in losses of volatile matter above temperatures of 100°C. might indicate that there will be an appreciable loss of volatile matter at 100°C. when solids are exposed to this temperature for any considerable time after they have become dry. Results obtained, at lower temperatures after varying periods of drying bear out this assumption. Our studies indicate that without doubt there are errors in the solids determination as practiced now in laboratories on sluge samples.

Distillation of volatile matter from dry solids appears to be very rapid. The distance between the 20 and 30 minute curves is much less pronounced than that between the 10 and 20 minute curves in Fig. 2. At 200°C. and above, however, the distance appears to be almost constant which indicates that at these higher temperatures the penetration of heat is more rapid. It appears then, that the rate of distillation of volatile matter is very rapid during 20 minutes with some lag in the heat penetration in 10 minutes, especially at the temperatures below 250°C. Increasing the time of exposure from 20 minutes to 30 minutes does not proportionately increase the amount of volatile matter driven off.

Probably the most interesting results from the standpoint of sludge drying are shown in Fig. 4, where the effect of moisture in preventing the distillation of volatile matter is demonstrated. In spite of the searing action which is likely to take place at the surface of the material, there is little evidence of volatile matter loss as long as 10 to 20 per cent of the total moisture originally present remains. For given increases in temperatures there is a proportionate increase in the amount of moisture driven off up to approximately 80 per cent, but above 80 per cent of moisture lost, increases in temperature do not proportionately increase the amount of moisture driven off. Examination of the corresponding curves of volatile matter loss show that very shortly after 80 per cent of moisture has been expelled the volatile matter begins to distill off. It appears then in order to prevent excessive losses of volatile matter during drying operation the material should not contain less than 20 per cent moisture if it is to be exposed to high temperatures in the drier, and further, losses in volatile matter also depend on uniform drying of the material. If incineration is practiced subsequently the remaining moisture after the drying operation can be taken care of during the burning process without odor production.

Summary

Sewage sludges of different volatile matter content (first dried at 100 to 105°C.) and wet sludge containing 75 per cent moisture were exposed to temperatures from 150°C. to 400°C. for different intervals of time.

Large amounts of volatile materials are distilled off from dry solids at temperatures from 150° C. to 400° C. The amount of volatile matter loss during equal time intervals was proportional to the temperature up until 70 to 80 per cent of the volatile had distilled off. The *rate* of volatile matter loss does not seem to vary with the volatile matter content of the original sample. There does not appear to be a temperature between 150° C. and the combustion point at which there is not an appreciable loss of volatile matters.

Distillation of volatile matters from sludge containing 75 per cent moisture did not occur until 80 to 90 per cent of this moisture had been driven off, regardless of the temperature. In drying operations with subsequent incineration, a moisture content of the sludge from 20 to 30 per cent would probably prevent nearly all odor trouble and reduce heat required in the combustion step.

▼

Detroit Water Works Drop 130 Men

An economy program designed to save $388,000 per year has resulted in dropping about one-third of the salaried staff of the Detroit Water Department. The entire construction staff has been eliminated and the department placed on a maintenance basis only. Among the men let go are the superintendent and assistant superintendent of construction, the engineer of the water system, the engineer of inspection and tests, the assistant superintendent of maintenance, nearly a score of engineering assistants and about twenty foremen. This took effect on May 3rd, and it is reported that a shrinkage of revenue to the extent of about $1,000,000 has occurred during the past year.

THE 52ND CONVENTION OF THE A. W. W. A.

A Digest of Committee Reports, Papers and Discussions*

The New President A. W. W. A.: Geo. W. Pracy, Superintendent, Water Department, San Francisco, Calif.

Delayed delivery of a handsome gavel to Ross Dobbin, as retiring President of the A. W. W. A., was responsible for failure of Mr. Dobbin to acknowledge its receipt during the Convention.

The gavel was presented by Mrs. John M. Diven, Sr., widow of the late Secretary of the Association and the acceptance of this appreciated memento by Mr. Dobbin is here acknowledged at his especial request.—Editor.

Water Works Betterments

FOLLOWING the presentation of a report by the Committee on Immediate Water Works Betterments by **E. S. Chase** in the absence of Chairman **H. P. Eddy** the statement below was read by **Malcolm Pirnie,** Chairman of the Committee on Water Works Practice, an active member of the Committee on Betterments and a "wheel horse" of the Association. The Committee reported on its several attempts to gain the assistance of House and Senate committees at Washington but without success and requests for Federal assistance in financing needed water works construction had fallen on deaf ears so far.

Action by American Water Works Association to avert crippling water service and to provide employment of nation wide distribution on necessary public works, with resulting equitable allocation of the buying power created.

A.—The American Water Works Association in its 52nd Annual Convention at Memphis is gravely concerned over the critical condition of water works throughout the country, which is arising from the stoppage of normal improvements, postponement of needed betterments and curtailment of trained operating staffs, and by the large increase in unemployment due to vanishing construction work.

B.—It finds that public health, community welfare and property are being jeopardized by water service crippled for meeting normal demands, or by complete lack of water supplies in communities large enough to need and support them. It recognizes also that the continuance of adequate service absolutely depends upon present construction of those facilities which will be needed in the immediate future.

C.—It has already made a study which shows: that the lag in normal water works construction plus those improvements needed to maintain or raise the standard of service amounts to $500,000,000, that this cost can be supported by relatively low charges for the service rendered (the increase average less than 50 cents per capita per year to those who benefit) and that many of these improvements are already planned and can be started without delay.

D.—It is convinced that this necessary construction offers the readiest opportunity for creating large scale employment on sound self-supporting public works of nation wide distribution, thus equitably allocating the buying power which would be created.

E.—It finds that public opinion, led by opinion of private financial and investment services, in concert with the wholesale measures being taken to reduce other community services that are paid out of tax money, has caused the abandonment of water works projects already authorized and the refusal to finance or even consider new ones, regardless of their merits or the resulting loss in property, public health and general welfare.

F.—Recognizing the vital necessity of safe and adequate water supplies and of distribution facilities sufficient not only to deliver water to consumers but also to protect property against fire, the American Water Works Association urges upon citizens and the national government prompt and effective action to:

1. Revive current reinforcement and betterment construction.
2. Maintain full water service by insisting on continuance of normal operating staffs of experienced men.
3. Initiate improvements to provide uniformly high standards of quality, service and fire protection.
4. Provide means for assuring adequate credit at reasonable rates to water works systems.

Mr. Pirnie's motion that water works officials proceed promptly to attempt to interest Congressional representatives in the needed work was seconded by **Dennis F. O'Brien** of the A. P. Smith Manufacturing Company, a Director of the Association. **S. B. Morris,** also a Director, pointed out the possible saving of 20 per cent by proceeding with construction and improvements promptly, even though the rate on 20-year bond issues might be as high as 7½ per cent. **Col. W. T. Chevalier,** President of the Water Works Manufacturers' Association, added considerable by making a clean cut statement in seconding Mr. Pirnie's motion. He said that there were two ways out—the "dole," or expenditures in a public works construction program—and that the latter would provide a healthy way of putting men and factories to work with lasting benefits resulting. Within twelve months one or the other had to be faced and there should be no question as to which was preferable.

Mr. Pirnie's motion was carried unanimously.

Unpaid Water Accounts

In reporting the Superintendents' Round Table in the May issue, the topic assigned **W. Z. Smith,** General Superintendent of Atlanta, Ga., was unintentionally omitted. Mr. Smith in opening the discussion of the topic—**"Action Taken as Result of Non-Payment of Water Bills During the Present Depression"** said, that water was so much an essential element to life and health that shut-offs of service were not made in Atlanta unless the investigation made showed that the taker could have made at least partial payment on the bill. Consumers without work were being carried until such time as they obtained employment, when it would be required that the monthly partial payment method of liquidating the account be followed. Charity cases in Atlanta are carried without payment of water bills, but care is taken to check on such cases and where imposition or deceit has existed the water is shut-off promptly The carrying of customers is not wholly for sentimental reasons but the general good of the community has to be considered in times such as now exist,

*Editors' Note—In WATER WORKS AND SEWERAGE for May there was reported in digest form the Discussion in the Superintendent's Round Table Meetings and papers and discussions in the Water Purification Division meetings. Lack of space prevented full coverage of General Sessions—topics which are being reported now.

and further because water is more than a commodity —it is a necessity.

A. F. Porzelius, Superintendent Chattanooga Water Company—a privately owned system—reported that they had given temporary employment to delinquents who really wished to "work out" their debt for water. That was a partial solution to a vexing problem.

C. H. Grinnell, Superintendent Water & Light, Grand Rapids, Mich., reported about the same practice at Grand Rapids and also said that extension of time for payment had been allowed delinquents.

Patrick Gear, Superintendent at Holyoke, Mass., reported more unpaid water bills than for 10 years. Services are never shut off, but payment of bills had to be forced in instances.

W. W. Brush remarked that in New York City the water bill constitutes a lien on the property served and therefore collections had been satisfactory. (Mr. Brush did not mention the fact, however, that the New York Supreme Court had ruled recently that water being in nature an essential to health and life was not to be classed with other commodities and, therefore, ruled that water supply must not be cut off from the users occupying hotels, apartment houses or rented property. This court also ruled that the receiver of bankrupt properties could not be held liable or forced to pay water bills which had accumulated prior to such receivership. See Editorial—"Receivers and Red Ink," WATER WORKS AND SEWERAGE—March, 1932.—Editor.)

Thos. J. Skinker of St. Louis, Mo., reported that failure in collections had been most pronounced in the case of hotels in St. Louis.

Supplies from Deep Wells

"The Memphis Water Supply" was described in a joint paper by **F. G. Cunningham** and **Wellington Donaldson** of the staff of Fuller & McClintock, Engineers, New York City.

The Memphis supply was formerly taken from a deep tunnel into which was connected wells that would flow in at that elevation. The water had been pumped from a deep shaft and had been responsible for outbreaks of water borne disease. It was a highly corrosive supply already impregnated with high amounts of carbon dioxide gas and ferrous iron. The new supply is taken by air lift from 31 deep wells to the extent of 19 million gallons per day. It is then aerated by a "splash and film" process employing coke-beds in four shallow trays, one above the other. The iron present is precipitated, sulphur and carbon dioxide removed and is filtered through conventional rapid sand filters. When purified thus, the Memphis water is perhaps of the most satisfactory chemical quality and highest purity of any large water supply in the world. The water before leaving the wells contains 120 p.p.m. carbon dioxide and among the reasons air lift pumping (100 ft. lift) was selected had been because of its efficacy in driving out a high percentage (75 per cent) of carbon dioxide at the individual wells. Furthermore, oxygen requisite in precipitation of the iron later is introduced. This had been effective also in reducing the area of coke beds and head required in the aeration works at the filter plant. Memphis is now building its second plant, practically a duplicate of the first. **Mr. Cunningham** remarked that the present consumption of 19 m.g.d. for Memphis' 250,000 population did not represent the per capita usage because there had been developed so many privately owned well supplies—particularly by industrial consumers and hotels. The new Sheahan Station and the Parkway Station, designed by Fuller and McClintock and built in 1922, was described. Impressive, was the comparativce costs of this new station with that of the Parkway Station in 1922. The new 30 m.g.d. capacity plant will cost $1,750,000 as against the older 28 m.g.d. plant at $2,500,000. That serves as concrete evidence the resaon for advocating construction of utilities works at this time.

Regarding the quality of the Memphis water, the authors stated that it is absolutely free of permanent hardness, its satisfactory quality being due to natural softening through sands possessing zeolytic properties. The total alkalinity is but 60 parts per million and total solids about 80 p.p.m. No chemical whatever is used in its treatment—other than oxygen from the air.

Special features of the Parkway Station are the economical compressor system installed (90 lbs. operating pressure) and the running of low lift (25 ft.) centrifugal pumps by water turbines operated from the high pressure main. From the turbines the power water proceeds through the compressor cooling chambers and returns to the suction side of the high service pumps. The authors remarked on the simplicity and economy of such a scheme.

Malcolm Pirnie, Consulting Engineer, New York City, in discussing Cunningham and Donaldson's paper pointed out the effective use of contact gravel beds employing the upward flow principle for removal of soluble iron from water supplies. He had designed two such plants—one at Long Beach, N. Y., and the other at Punta Gorda, Fla. Both had proven successful if not overloaded and provided excessive aeration was not given the water *ahead* of the contact units. For small works this scheme was particularly attractive and inexpensive.

"Construction and Maintenance of Deep Wells in Sand Strata"—W. G. Lanham, Resident Engineer, and **Thos. H. Allen,** Consulting Engineer, Memphis Water Department.

In this presentation the authors pointed out that both the gravel envelope and slotted screen type of wells had been satisfactorily used in the lower Mississippi Valley territory. The several types of well screens were discussed as was the development of the gravel envelope well. It was pointed out that the water strata level was gradually lowering at Memphis with the continued draft of about 30 m.g.d. taken from the wells in and near Memphis. The field would have to be extended some to preserve the ground water level in that area.

A written discussion by **D. W. Lane** of the Los Angeles Water Department, recounted Los Angeles' experiences with 395 wells put down during the past 35 years and listed the several causes of well failure. Few people realize that Los Angeles takes a fair portion of its water supply from the ground to supplement the surface supplies.

Deep Well Pumps

D. J. Conant of the Layne and Bowler Corporation, discussed **"Turbine Well Pumps—Their History and Development."**

In preparing this paper Mr. Conant had the assistance of **A. O. Fabrin** also of the Layne and Bowler Corporation. Mr. Conant's key note was the advisability of close cooperation between purchaser and

pump manufacturer if the utmost in efficiency and service was to be gotten from well pump installations. The character or quality of water must be considered in pumping problems and metals and alloys of suitable quality were available for use in pump manufacture provided the manufacturer knew what was to be expected in the problem before him. The newer alloys had helped to solve pump troubles formerly unsolved. He stated that deep well pumps of turbine type had been successfully used at depths up to 825 ft. and with output up to 10,000 gallons per minute. With proper planning and installation of turbine pumps their efficiency could be maintained at a high point for very long periods of time. At outputs under 1,000 gallons per minute and against moderate heads he had found that multi-stage turbine well pumps equal or exceed the efficiencies procurable from standard horizontal centrifugal units. Mr. Conant discussed the impulse, reaction and mixed flow types of pumps—each having its place in deep well pumping. The latter being a combination designed for high delivery against relatively high heads and variable heads, is therefore a highly practical type for well pumping where the draw down covers a wide range during pumping and the desired yield must be more or less constant.

Large Flow Metering and Rate Control

Chas. G. Richardson, Chief Engineer of the Builders' Iron Foundry Company, reported on **"Recent Developments in Metering and Flow Control Equipment."**

Mr. Richardson outlined the problems which had been assigned his company in recent times, wherein special and novel features had to be incorporated in control and measuring devices at the newer water treatment and sewage disposal works. He reviewed the problem at the new Albany, N. Y., filtration works and described the operation of the Venturi meter and controller which serves as master-control equipment to maintain constant water level on the filters without causing a surge effect or "hunting" action. A special "brake" or governor had been designed which maintains a variation of 1.08 in. in water level in basins and on the filters, with a flow variation being maintained between 21. and 22.5 m.g.d.

At the new plant at Ottawa, Ont., three problems had been given and solved to the satisfaction of the designing engineers. Through installation of a master controller on the effluent line, with one operation the rate of flow through all filters can be changed simultaneously. Another was the arrangement for automatically opening the master controller to maintain a definitely minimum depth of water in the clear well. The third had been the arrangement of recording equipment on the filter operating tables so as to have one instrument indicate and record the filter rate, loss of head and the wash water pressure. A two pen instrument had been developed to record the three values—the loss of head pen serving the dual functioning of recording wash water pressure during washing, as well as the loss of head during filter service.

At New Haven, Conn., a Venturi meter actuates a storm water by-pass gate which is automatically opened during storm flows to bypass all except the predetermined capacity of the treatment works. As the flow returns to normal the gate gradually and finally closes to remain closed until another storm flow reaches the plant.

H. B. Smith of the Simplex Valve & Meter Co., in discussing Mr. Richardson's paper said that the cost of such specially designed equipment was necessarily high but if special cases justified such special handling, the cost was perhaps reasonable regardless of the fact that it would be materially above the cost of measuring and control equipment produced in volume.

Cast Iron Pipe Linings Prove Value

"Linings for Cast Iron Pipe and Their Application"—D. B. Stokes, Vice-President, and **H. G. Reddick,** Engineer, United States Pipe & Foundry Co., Burlington, N. J.

Mr. Stokes reading the above paper discussed tuberculation of cast iron pipes and the various types of protective linings now in use to prevent tuberculation and corrosion with its consequent friction loss. Difficulties with cement linings had largely been one of hardness increase and loosening of lining especially troublesome in large sizes. Bituminous linings had proven the best and now a pitch-base material with a mineral filler was showing promise of being overall the most satisfactory coating material. A moving picture of the process of the primer coating by dipping and hot Bitumastic enamel centrifugally applied at 420° F. was shown. Mr. Stokes said that the coating as applied must be non-brittle and non-running between zero and 170° F.

In reply to questions from **A. U. Sanderson** of Toronto, Mr. Stokes said that lining of specials was done by brushing on two or three coats by hand. Bitumastic had a pitch or coal-tar base, whereas Hermastic had an asphalt base and was therefore not as satisfactory for pipe coating.

George Boyd of the Wales-Hermiston Corporation said that coatings with coal-tar base would have longer life than asphalt which would disintegrate in 15 years. Bitumastic was known to be good for 25 years.

George Pracy, Superintendent, San Francisco Water Works, said that asphalt used in California had given excellent service for 47 years.

The firm of Alexander Potter, Consulting Engineers, of New York had put in a system at Persippany Hills, N. J., using Bitumastic lined pipe and the opportunity had been available to make a study of several miles of that pipe under actual field conditions. **L. B. Killam,** a member of Mr. Potter's staff who had had charge of the tests made, reported that on the 18,000 ft. run of 10 and 12 in. pipe line the value of "C" in Hazen & Williams' formulae had proven to be 150 as compared with 100 for new pipe and that meant in common terms that the line had a carrying capacity 50 per cent greater than unlined pipe. Mr. Killam reviewed the procedure followed in making the friction and flow determination on this large scale test (2,400 g.p.m.) for a duration of 1 hour and 16 minutes. The data had shown "C" = 152 in first 9,000 ft. section and 148 on the last 9,000 ft., giving the average of 150 under very practical conditions. His firm had felt that the added cost for lining had been justified.

W. W. Brush, Chief Engineer, New York Department Water Supply, inquired whether lead would prove satisfactory for joints when using Bitumastic lined pipe.

Mr. Killam replied that by test, molten lead had caused the lining to burn and flow at the joint, whereas the substitute jointing compound used (in this case "Hydrotite") had not. In another case lead had been used with considerable care to avoid heating above 750° F. but for practical reasons the use of joint compound has proven preferable.

Jas. E. Gibson referred to his advocacy of lined cast iron pipe back in 1923 and was pleased to note the advances that had been made. Because of the corrosive nature of the Charlestown water he perhaps had felt the need of linings earlier than most people.

Causes of Water Losses on Distribution Systems

Somewhat of the nature of a symposium on the topic of the **"Causes of Water Waste on Distribution Systems"** made up one of the General Session's programs. The introductory paper was that of **Alfred E. Skinner,** Western Manager, the Pitometer Co, who said that hidden underground leaks were perhaps the most serious sources of lost water, but that the wrong size of meters might be responsible for unaccounted for water. Oversized meters underregistered and undersized meters suffered serious wear. Pump slippage might be considerably greater than assumed and thus the water metered and pumpage might check fairly closely even when water losses existed. An interesting disclosure was the "stealing" of water by metered consumers who would run a very small stream continuously into tanks from which heavy drafts might be made at will. The trickle flows would not be recorded by the meter in most cases. Chinese laundries had been practicing that trick for years. It apparently was an old trick because getting paid for water actually consumed in large cities in Illinois was a real problem. Underground leakage flowing into sewers unseen constituted an important source of losses and Mr. Skinner felt that cooperation of the Sewer Department would prove helpful in locating such leaks. A frequent source of undetected leakage had been found to be where pipe lines crossed under streams. Flush tanks on sewer ends if improperly maintained would create a very important water loss as had been proven. Blown joints was perhaps the most serious source of water loss so far as the mains proper was concerned.

In reply to a question **Mr. Skinner** said that 85 to 95 per cent of the water entering the distribution system should be accounted for by the meters and that seems practical of attainment. **Jas. E. Gibson** reported that they at Charleston could account for 80 per cent and **E. O. Sweet,** Superintendent, Birmingham Water Company, said that the method followed in meter reading had an important bearing on water accounted for. The rotary system of meter reading at Birmingham was used and there 74 to 76 per cent of the water pumped was registered by the meters.

L. H. Enslow confirmed the advantage of having the cooperation of the sewer department in leak location, by citing an experience in California where corrosion of a water main from the exterior by hydrogen sulphide gas from a sewer had caused a pronounced leakage into the sewer. This had been discovered during a survey to determine the source of odors from that sewer. It was not a common occurrence but served as an illustration of the assistance that the sewer department might render.

Thos. J. Skinker of the St. Louis Water Department, said that house to house surveys had been responsible for reduction of considerable water waste in St. Louis. In 1930 and 1931 a total of 15,600 fixture leaks had been corrected as a result. Only 9.7 per cent of St. Louis consumers are metered and those were the larger users of course. Meters could be and were being ordered installed in cases where marked leakage had been reported and were not promptly corrected. They had found household waste to account for 7 per cent of water loss while underground leakage was about 1 per cent. To his mind meter installation was the only way to permanently stop wasting of water by consumers and allowing leaks to go uncorrected. He felt that the use of the longer lengths of pipe and better caulking of joints were two means of reducing underground leakages. Where corrosive soil conditions were met the pipe might be laid in and covered with crushed limestone to neutralize the acids.

"Underground Waste Detection in New York City's Water Conservation Program" was the subject dealt with by **F. B. Nelson** of the Department of Water Supply, New York City.

Mr. Nelson said that leaks on the mains in Manhattan and the Bronx rarely ever come to the surface. He reviewed the plans and accomplishments of the leak survey proceeding under his direction. Important water savings in earlier work had resulted at a cost of $4.58 per m.g. of water loss stopped and that 8 to 18 m.g.d. water waste had been corrected annually. In 1931 a more intensive survey had been gotten under way. The "preliminary survey" to correct the most important and easily detectable leaks had been completed. They had spent $46,800 in the work of the special four group survey forces and in 1931 had stopped 176 leaks representing 26. m.g.d. leakage. The cost estimate was $2.42 for each million gallons saved. The author reported on methods used in computing the volume of leaks which had been checked against Pitometer measurements where possible. The estimates had been in all instances conservative—actually 8 per cent below the Pitometer check. His experience would justify the advocacy of underground waste surveys as regular maintenance work—the extent to be determined by local conditions.

H. S. Morse, General Manager, Indianapolis Water Co., could not be present, but his written discussion of the papers by Mr. Skinner and Mr. Nelson was read by **Wm. C. Mabee,** Chief Engineer of the company.

Mr. Morse reported that Indianapolis Water Co. customers were now practically 100 per cent metered. They had recently been able to account for 86 per cent of the water entering the system. Of the 14 per cent not accounted for they estimated 4 per cent had not been registering while passing meters and 2 per cent deficiency was due to the intentionally low setting of meters. One and eight-tenths per cent (1.8 per cent) went to flushing and fires. The average dripping faucet would waste 15 gallons per day and that would not be registered by the meters, and with an estimated 2.9 per cent loss as underground leakage (100 gallons per mile per day) a total of 96.8 per cent of the water could be accounted for—the remaining 3.2 per cent could not be. The company had removed and repaired 523 non-registering meters per year at an estimated non-registration of 1.125 m.g. per day for all consumers. Mr. Morse also com-

mented on the "Chinese method"* of water stealing by continuous running of a thin stream which would not register on the meter and might represent an appreciable figure in the total.

"Breaks in Cast Iron Pipe Systems—Causes and Remedies" was dealt with in a highly instructive paper presented by **Wm. C. Mabee,** Chief Engineer, Indianapolis Water Co., Indianapolis, Ind.

Mr. Mabee gave the Association the benefit of their observations for a period of years at Indianapolis which had disclosed the fact that an average of 1.74 breaks on the distribution system (gridiron) had been recorded per year for each 100 miles of the 368 miles of main. That included breaks from all causes and with the elimination of corrosion by electrolysis, now on the decrease, that figure would be reduced to 1.22 breaks per 100 miles per year. He had not been able to find that the failures were influenced by increased age of pipe and since they had not gone to the centrifugally cast DeLavaud pipe, that type was not included. They had had 222 breaks in 35 years. He named eleven classifications of breaks but there had been but five distinct causes, viz.: Electrolysis, settlement, vibration, pressure increase and defective pipe. Defective pipe had accounted for 6 per cent of these. The greatest cause (35 per cent) had been due to electrolysis caused by the street railway system. The next in importance had been settlement of mains—responsible for 26 per cent of the breaks. Vibration and increased pressure during fires had each been charged with causing 7 per cent of the breaks, and 4 per cent could be charged to external blow by steam shovels, back filling, etc. The same percentage had been caused by freezing. Water hammer caused by quick closing of valves had been responsible for only 2 per cent and miscellaneous causes accounted for the same. In reply to a question Mr. Mabee said that there was no seasonal relationship to breakage frequency.

Thos. F. Wolfe, Research Engineer, Cast Iron Pipe Association, Chicago, in discussing Mr. Mabee's paper, recounted the care taken in manufacture and the rigid inspection and tests given each length of cast iron pipe at the factory and said that the common causes of failure in the field occurred in the following order of importance, viz., settlement, poor construction practice, temperature changes, vibration and fatigue, pressure changes, defective pipe; and electrolysis was usually the least responsible, whereas in Indianapolis it had ranked first. Detroit had recently recorded but 4.5 breaks per 100 miles of main per year with a total of 122 breaks and Chicago had (1931) 142 breaks, equivalent to 3.8 per 100 miles. These compare with Indianapolis' 35 year record of 1.74 per 100 miles and modern pipe should give even a better record in the future.

Thos. F. Wiggin, Consulting Engineer, New York City and member of the C. I. Pipe Standards Committee of the Association, made the following comments: From studies made by the Association Committee they had concluded that most failures were due to defects inherent in the pipe and not ground causes. Inspection prior to laying pipe was of prime importance and then proper ramming underneath the pipe was also of considerable importance. It would be necessary to watch adjacent work, excavation in particular, to avoid settlement or side slip. The increased expense for manufacture of stronger pipe would not be sound economically and some breakage must be expected and tolerated. He thought that welding six and 8 in. pipe on the trench side to produce lengths up to 40 ft. before lowering would have distinct advantages. Thinner pipes now being used require added precaution to prevent impact damage during handling and backfilling.

Mr. Mabee, answering a question, said that Class "B" C. I. pipe is used in Indianapolis for pressures between 65 and 100 lb. and has proven satisfactory, but no centrifugally cast pipe had been used so far.

Jas. E. Gibson reported 141 breaks in 10 years at Charleston, equivalent to 4.5 per 100 miles per year.

Meterization and Increasing Revenues

"The Effect of Proper Sizes of Meters on Revenues" was discussed by **L. D. Gayton,** Assistant City Engineer, Chicago, Ill. Mr. Gayton said that proper sizes of meters on the more remunerative consumers services in Chicago had been given a deal of attention. As a result about $583,000 revenue increase had been effected during the past six years. That had been accomplished through a survey of important metered services. A recording device was attached to the meter and where low flows were indicated for any appreciable percentage of the day a smaller meter had been installed to replace the larger and less accurate unit. Recorded consumption was on the increase as a result, and the return in income was three times the cost of the program to date. Domestic services in Chicago are metered to a small extent only but the larger services yielded a high percentage of the income of the department and checking of the meters on these was given careful attention.

"Measures to Offset Prevailing Downward Trend of Water Revenues" were suggested in the paper of **E. E. Bankson** of J. N. Chester, Engineers, Pittsburgh, Pa.

Mr. Bankson said that the average water consumption since 1929 had been about 6 per cent. The industrial consumers were taking about 13 per cent less water. Proper size of meters and proper maintenance had a great bearing on income—experience showing that 30 per cent increase in revenues had been affected by attention to these items. He said that water works superintendents could take the role of sales managers and by so doing increase metered water consumption. He cited West Palm Beach experiences in fostering garden club work and that it had paid the water company to hire a landscape and garden expert to promote more gardening with consequent increased water sales. There had been other schemes employed elsewhere that had increased water sales. He suggested reduced operating costs through the reduction of labor, increased metering by municipally owned works and that more waste surveys be made. Taxes might be appreciably reduced by metering, which would frequently reduce consumption (more properly water waste) by 50 per cent and would increase employment. On the average only 77 per cent of the water pumped could be accounted for and that was hardly excusable. Mr.

*It seems that a stream just sufficient to flow continuously without breaking into drops is not measured by the majority of the meters after some service and the small stream used by gas refrigerators will usually not be registered unless there are other leaks to form a combined flow sufficient to motivate the meter. When the latter is the case, the consumers leaks are all registered and charged to gas refrigeration consumption because of the increased billing above that "guaranteed" by the refrigerator agent. —Editor.

Bankson thought that a downward revision of the rates for large consumers might be used as a means of increasing net revenue. The existing treatment works might stand an increased output at a cost which would yield a profit if sold at the lowered rate and make it feasible to supply additional industrial users with cheaper water than they could secure from their privately owned supply.

Myron B. Reynolds, City Engineer of Chicago, in discussion exhibited a chart showing that over a period of years the maximum work in Chicago water works betterments or extensions had always occurred during years when the dollar bought the least.

"Changes in Costs of Water Works Materials and Labor" was the subject of a paper by **Wm. W. Brush,** Chief Engineer, Department of Water Supply, New York, N. Y.

Mr. Brush said that the dollar spent now for water works materials and equipment would buy about twice as much as it would have three years ago. He advocated taking every possible advantage of such a situation. The need for an Association Committee to collect data on price changes in labor and materials in various sections of the country was stressed and would be referred to the directors for action. Mr. Brush said also that public utility rate structures should be stabilized and not changed so frequently to meet new valuation. He advocated a movement to establish a minimum of five years between allowed changes of rate structures.

W. A. Hardenberg, Associate Editor "Public Works," New York, reported on the changing prices of equipment during the past seven years. The cost per foot of laying 8 in. pipe had been averaged for 150 cities and was $2.21 in 1925; $2.02 in 1929; $1.75 in 1931 and only $1.42 in 1932—the last being 64 per cent of the 1925 costs and that agrees fairly well with the drop in construction costs which is 76 per cent of that of 1925. He suggested that construction work could be conducted on a stage program without the necessity of voting bonds. Furthermore, he advocated high grade engineering in design at an overall much greater saving than is secured by use of less expensive but mediocre engineering services.

"Recent Trends in Factors Affecting Rate Base" by **L. R. Howson,** Consulting Engineer, Chicago, Ill.

Mr. Howson said that judicial opinions have been defining valuation methods in the public utility fields The courts had held that such factors as accrued depreciation and annual depreciation used in making rate bases and arriving at operating costs should be based on present reproduction costs rather than original investments. The value of good-will and going-value are more difficult to arrive at but can be evaluated by the same engineering principles as are employed in making other appraisals.

"The Use of Improvement Reserves for Leveling Financial Peaks and Valleys," by **V. Bernard Siems,** of the National Water Works Corporation, New York, N. Y.

Mr. Siems' paper called attention to the desirability of setting aside funds during good years when money is cheapest, which would accumulate and allow the management to carry out its plans of betterments and improvements during depression years, when funds otherwise would not be available to buy the most for the dollar. Such a procedure would level the peaks and valleys of financing procedure in water works operation and maintenance but possibly the scheme would require a modification of the existing laws that regulate privately owned utilities.

Water Works and Fire Protection

"The Influence of Water Works on Fire Protection Classifications" was recounted by **Geo. W. Booth,** Chief Engineer, National Board of Fire Underwriters, New York City.

Mr. Booth said that water supply considerations at most represented but about one-third (34 per cent) of the total number of points taken into consideration by the Underwriters when arriving at the classification of cities. As the result of decreasing fire hazard the average premium per $100.00 for fire insurance had been reduced from $1.08 in 1910 to 77 ct. in 1932.

"Diversion of Water Between Drainage Basins" was the subject of an elaborate paper prepared by **Robert E. Horton,** Consulting Engineer, Voorheesville, N. Y.

Abel Wolman presented Mr. Horton's paper in abstract. The paper dealt with the legal as well as the engineering phases of diversion of the natural flow of waters from one shed into another. Mr. Horton thought that any water allowed to find its way to the ocean without having been put to some good use constituted a waste. He advocated the establishment of boards which might properly allocate waters of streams for various uses after making the studies necessary to reach an idea of future developments along the streams in question. In other words the author advocated a "Stream Plan" to be worked out by a capable body for each stream somewhat as "City Plans" have been laid down for municipalities.

W. W. Hurlbut, Engineer, Department Water Supply, Los Angeles, in his paper, **"Expansions on the Los Angeles Water Supply System,"** said that the underground source of supply at Los Angeles was an important one in that it was derived from water which had been previously taken for irrigation purposes from surface storage on the Los Angeles system. Much of the underground water, therefore, was made use of twice. Keeping pace with the rapid growth of the Los Angeles metropolitan area had been quite a problem in water supply practice and the underground source constituted a highly valuable auxiliary source, and being pumped directly into the system when required, it had an effect similar to elevated storage. The aqueduct projected to bring in the Colorado River water from the Hoover Dam is scheduled for completion in 1940.

Sedimentation Basins and Filter Washing

"Further Experiences with High Rate Filter Washing" was reported on by **W. C. Lawrence**—Superintendent, Baldwin Filters, Cleveland, O.

Following the development at Detroit which indicated that filter beds could be maintained in better condition by employing rates of wash sufficient to expand the sand bed to a greater degree than had been accomplished by the 24 in. rise generally employed, Cleveland adopted the high rate wash about three years ago. The wash water rate is varied with changes of temperature (viscosity) so as always to produce a sand bed expansion (volume) of 50 per cent above that occupied by the bed in a unit in service. Considerably higher rates of wash have been required in Summer than in Winter to secure the desired expansion. Mr. Lawrence said that after

three years of this practice they had found that it met all claims for it. Wash water consumed had been 33 per cent less per year and filter runs had been increased by 66 per cent. The high rate wash had been supplemented by hand raking of sand beds every eighth week. It was the practice to rake 25 per cent of the units every two weeks to loosen the organic matter in the top sand and this in conjunction with high velocity wash had kept the beds in excellent condition.

"Sedimentation Basin Design" was discussed by **Arthur B. Morrill,** Assistant Engineer, Filtration, Detroit, Mich.

Mr. Morrill said, that in addition to the uniformity of flow and displacement in sedimentation basins there were other factors that influenced efficiency of sedimentation. The relationship of basin surface area to volume was less important in the case of coagulated water than would be true of granular or crystalline materials amenable to settling out by gravity. With water containing coagulated particles the volume of the basin or, more properly, the displacement time is the more important factor. He felt that particular attention should be paid to inlet and outlet arrangements to avoid floc dispersion and thought "round-the-end" baffles objectionable and unnecessary. Sedimentation basin design could be materially improved with some study or thought given the problem. Mr. Morril suggests an index for use in evaluating the efficiency of basin displacement. That index is arrived at by dividing the time required for 90 per cent of the water to pass through by the time required for 10 per cent to pass. An index of 1. would represent perfection.

Boiler Feed Water Studies

Sheppard T. Powell, as usual, presented a worth while report as Chairman of the Joint Committee on Boiler Feed Waters which is being reproduced in abstract form elsewhere in this issue.

Two papers were read at the Committee meeting which was well attended.

C. H. Fellows and **W. C. Schroeder** reported on **"The Determination of Phosphates in Boiler Waters,"** which represented a report on research conducted at the University of Michigan under Mr. Fellows' direction. The subject of a paper by **J. K. Rummel,** Chemical Engineer, Babcock and Wilcox Company, Bayonne, N. J., was **"Control Tests for the Treatment of Feed and Boiler Waters,"** in which the tests for alkalinity, phosphates and silica were given especial attention.

Billing, Store Keeping and Materials Control

"Material Control Policies" was the topic of a short and instructive paper presented by **C. J. Alfke,** Comptroller, Hackensack Water Co., Weehauken, N. J., and Chairman-Elect of the Finance and Accounting Division before which the paper was given.

Mr. Alfke said that the installation of a complete system of materials control, although costly, had resulted in many economies and reduced inventories. In addition there should result a saving of cost and time of handling materials, in space saving in storing materials and in reduction of losses due to defective materials or materials not meeting specifications. In all, seven advantages derived from effective control of materials, and the necessary procedures to effect such, were discussed by Mr. Alfke.

"The Ledger Plan vs. the Stub Plan of Billing" was presented by **W. P. Adams,** of the Burroughs Adding Machine Co., Detroit, Mich.

Mr. Adams discussed the advantages and disadvantages of each system of billing. In recent years the advantages of the "bill and ledger" system had been more pronounced than formerly and was especially more effective when collections proved difficult. Furthermore, the records were kept complete even though a meter reading book was lost. The "stub plan" is more economical than the "bill and ledger" system but the latter has advantages that outweigh the economy argument. Since 1930 the majority of new installations have been arranged to use the "bill and ledger" system.

Manganese Removal

Malcolm Pirnie read in abstract the paper prepared by **E. C. Craig, R. L. Beam** and **Robert Sawyer** on the **"Use of Iron and Lime in Removal of Manganese."**

Mr. Pirnie having been responsible for the change from alum to the lime-iron treatment at the Providence Filtration Plant, was well qualified to present the matter. The use of this type of **alkaline** coagulation on soft and at times highly colored water is rather novel and has usually been considered unsatisfactory in soft water color removal problems. Mr. Pirnie said that the use of lime and ferrous sulphate at Providence had proven a most satisfactory scheme for removing the iron, the manganese, color and carbon-dioxide and simultaneously raising the pH value to that required to eliminate subsequent attack of the pipe system. Previously alum had been applied to the raw water and lime to the aerated filtered water to maintain pH of 9 but the difficulty had been a color increase and a serious after precipitation of manganese together with some iron in the conduits and pipe systems. In fact, as much as 8 tons of manganese had thus been thrown down in the system per year. Now the manganese and iron when naturally present in the raw water, supplemented by the addition of ferrous sulphate serve as "free" coagulants and are dropped out in the basins at the pH value of 10 being maintained for greatest efficiency. The precipitation of manganese with lime and alum had not proven practical. Experience had indicated that the iron should be added with rapid mixing *followed* by the lime addition rather than the reverse and to secure the maximum iron and manganese content in the raw water the bottom water had been drawn from the impounding reservoir. At the same time algae trouble was thus eliminated from the picture and the water was cooler. When the iron content had been 3 p.p.m. and manganese 0.75 p.p.m. the copperas required was but 0.16 gr. per gallon, but as these naturally present coagulants decreased the ferrous sulphate had been raised to 1.3 gr. per gallon. Roughly 1.2 gr. per gallon of hydrated lime had been required to secure pH of 10. The hardness increase had been 18 p.p.m. to a total of 38 p.p.m. in the filtered water. Complaints from consumers had decreased to practically nothing and dead ends were no longer continuously bled to the sewer as formerly when complaints had reached 115 per month in 1929 even with bleeding.

Mr. Pirnie said that ferric iron seemed superior to ferrous iron and that it was planned to change over to the use of some form of oxidized iron and that ferric chloride or chlorinated copperas would be used.

"PRESSURE LOSSES IN CUSTOMERS' SERVICES"*

By H. W. NIEMEYER and J. A. BRUHN

Indianapolis Water Co.,
Indianapolis, Ind.

DURING the past year more attention has been given the matter of pressure losses in customer's services by the Indianapolis Water Company than in the preceding years. Local progress and development account for this increased consideration.

With the completion of a city wide meterization program at the end of 1931 the natural tendency is to lend as much assistance as is practical to customers in order to create a greater use of our commodity. On the flat rate basis where revenue depended not on the quantity of water consumed but on other factors such as number of outlets and types of equipment it was necessary to place certain restrictions on the usage of the public supply in order to hold peak pumpage loads within reasonable limits and to better control the operating costs. It is the policy of our company, through continuous efforts along all suitable lines, to increase or maintain the consumption by customers and thereby our revenue. We concur with the author who once wrote "Because the growth of any public utility depends largely upon the measure of its success in serving the public, one important index of the company's achievements in rendering distinguished public service will be the trend of the company's growth, over and above the natural increase in growth due to the increase of population, and the business development of the territory served; and more particularly the degree to which the company now is serving its potential market." The customers and the utility will obviously benefit mutually through the greatest possible utilization of the water company's service or product. While competition for domestic accounts in Indianapolis is negligible the efforts of pumping equipment salesmen and other interested parties are a constant threat tending toward the reduction of revenue from commercial consumers through the installation of privately-owned industrial water supplies.

Another factor, resulting in closer study being made of service line pressure losses, is the attitude of the Indiana Public Service Commission with respect to requiring water companies to maintain and replace existing service where repairs are needed or the delivery is inadequate because of a growth of the consumer's demands. Following this tendency on the part of the Public Service Commission, but without order from that commission, we have agreed to do the necessary repair and replacement work on customer's services at our expense. It is interesting to note in this conection that answers to questionnaires sent out recently to all sections of the country by a sub-committee of the committee on Water Works Practice, American Water Works Association, show that in 64 per cent of the plants the original service lines from the main to the property line are paid for by the customers, and 68 per cent of the water companies at present, repair and replace inadequate services in the street at the expense of the utility. In cities where there is no annual service charge, whether water is used or not, it does not seem logical or just that the water company should bear the original cost of services because the expense including depreciation and maintenance must necessarily be passed on to the other water consumers of the city and that results in unfair discrimination. The closer contact established with inadequate service problems during the past year has made it advisable to secure all relative information available from outside sources to supplement our own experiments and field work in Indianapolis.

Sub-normal or inadequate water service, whether caused by factors under control of the water plant or due to conditions within the customer's property, usually always result in complaint against the utility, and if not properly cared for, will eventually tear down good public relations. Water Works Practice Committee No. 9 of the A. W. W. A. has considered the matter of "Service Lines and Consumer's Plumbing" of sufficient importance to place it on a par with "Pumping Equipment," "Source of Supply Structures," and "Boiler Plant Equipment" in their Public Relations Rating Scale for water utilities Regrettable though it is, the average user of water without considering the real cause of unsatisfactory flows at fixtures or for sprinkling use, blames the water company. It has been our experience that in many cases inadequate service due to numerous causes such as undersized piping, defective fittings or poor installation, worn or small sprinkling hose, faulty heaters and softeners, or obstruction in the service line has been tolerated for long periods by customers without complaint to us. Although no inquiry had been made concerning the service, there may have been a question in the user's mind—sometimes expressed to others—relative to the efficiency of the utility's service.

Causes of unsatisfactory volume of water at outlets which the customer inevitably terms "poor pressure" may be divided into three classifications:

(1) Minimum static pressure in distribution mains.

(2) Service line (size, length, material, obstructions preventing normal flow) meter and connections, necessary valves and cocks are included as part of the service line.

(3) Interior piping.

Our estimate on pressure inquiries received from consumers during the past year show that approximately 60 per cent are the result of item number three, viz: faulty interior piping. The balance practically all come under classification two or a combination of two and three.

During the past five years there has been a marked increase in the demand for water through changed standards of living, new types of plumbing fixtures, lawn sprinkling devices, and cooling equipment. Improvement and enlargement of service lines and interior plumbing have not kept pace with the greater demand. This appears to be more or less a natural development and one contributing factor may be that competitive plumbers when figuring on additions to existing systems estimate on smaller piping in order to keep the cost down and thus increase their possibilities of securing the job. It would of course be more satisfactory and permanent policy for the owner to have specifications prepared to cover the work by a competent authority.

For the past several years all inquiries coming to the Indianapolis Water Company, whether by letter, telephone, or directly from consumers have been cleared through a division of the commercial department. On those requiring an investigation monthly records are kept

*A paper read before the Indiana Section of the American Waterworks Association.

and letters written informing the customers regarding the matter. The monthly report on inquiries received bears the following information classified in groups according to the nature of the inquiry—name, address, explanation or cause, date of disposition, and a summary on the total number of inquiries.

General inquiries may originate in any of several departments and are sent in triplicate to the inquiry division which distributes them to the proper investigating department, one of the copies being kept as a check to make sure the matter is properly consummated. From the investigating department a report goes back to the Inquiry Division which, providing the information seems satisfactory, informs the inquirer by letter. The department doing the investigating keeps a record of each case for future reference. The present inquiry system seems to work smoothly and we receive many favorable comments from customers regarding the service given by this division.

Use of Gauges and Test Meters

The usual procedure on pressure or volume inquiries is for the inquiry division to refer the matter to the Service Department which first sends out the district man who covers that section of the city. Many times this man can locate the cause of the trouble when it is due to faulty heaters, furnace coils, softeners, partly closed valves, stuck meters, and so on. However, should his report not seem conclusive or satisfactory to the superintendent of service and the inquiry division two other men investigate the case with pressure gauges and a test meter. The test meter carries gauges on the inlet and outlet sides which facilitate the work. These men by observing the gauges on the meter and one on the highest fixture make a report of drops in pressure for various size flows. A stop watch is used to clock the various registrations on the test meter. By opening first one outlet and then additional ones the location and extent of the trouble can be found. These data along with additional information as to size of corporation cock, length and size of service line and interior piping, and static main pressure are turned over to the superintendent of service who can easily determine whether or not the pressure loss in the service line and interior piping is more than normal. The inquiry division then studies the monthly consumption of that particular customer, nature of their business, and probable peak requirements, after which recommendations are made as to disposition of the case.

Causes of Inquiries

For the year 1931 experience indicated that on about 60 per cent of the pressure inquiries the causes were due to matters under the control of the customer. These were such as inadequate main line piping in the property, defective water heaters, furnace coils, softeners, valves, and fixtures. Approximately 25 per cent resulted from some obstruction in the corporation cock, curb cock, service line, meter yoke, or meter. The balance proved to be a combination of inadequate service line and small inside piping. Under our present policy reports are made to the responsible parties as to the cause of the trouble and steps recommended for its elimination. We have found that in cases where both the service line and inside piping are inadequate it is wise to have the customer make his changes *before* the service is enlarged in the street—otherwise the inside work may never be done.

A good test as to whether the customer is inconvenienced by lack of volume is his willingness to make some expenditure on larger inside piping in order to better the situation. In a few cases consumers have been unreasonable in their requests that the water company replace their services. If the company installed these at the whims of individuals without first making careful investigation, capital investments would be rapidly and unnecessarily increased.

In Indianapolis a minimum pressure of 55 lb. is carried in the central section of the city and with the exception of the Eastern District where a 1½ million gallon elevated storage tank assists in maintaining good pressure, the elevations are such that normal pressure is greater than in most cities of the United States. Therefore troubles due to poor distribution pressure are not present.

Due to the chemical nature of the water supply, the character of the soil, and the fact that lead services seem to work satisfactorily in Indianapolis, we do not experience serious service line difficulties. In a few cases where examinations were made in our laboratories of parts of old lead services removed we find deposits which the filtration department attributes to weak electrolytic action due, not to external causes, but normal physico-chemical phenomena. The number of these is not extensive and in general we are fortunate with respect to service trouble caused by corrosion, tuberculation, or nodulation.

In Indianapolis the greatest cause of poor pressure difficulties is lack of intelligent foresight on the part of plumber, builder, architect, or property owner. The tendency is toward too liberal use of "rule of thumb" methods for calculations and failure to recognize the fact that demands for water have increased. Investigations constantly reveal "overloaded" inside piping systems. The adoption of "a factor of safety" on new installations would allow for future additions to systems and should eliminate many troubles now experienced. Some customers through false economy and purchase of questionable size water pipe make satisfactory service practically impossible. The greater use by owners, plumbers, and architects of the available experience of water works men should help materially in decreasing the number of inquiries on poor service.

During our studies of pressure losses in customer's services, requests were sent to the following water companies in the country to learn their procedure in investigating such cases. Pennsylvania Water Company, San Francisco, Hartford, Milwaukee, Detroit, Hackensack, Scranton, Spring Brook, and New Haven. Their policies are essentially the same as described for Indianapolis—the amount of attention and study given the matter being determined by:

(1) Local water supply and soil conditions.
(2) State rulings as to responsibility for services.
(3) Type of management.
(4) Desire to increase good public relations and revenue.

Technical Side of the Question

The discussion up to this point has been confined chiefly to the relation of the subject to general local conditions and factors. Now some thought should be extended to the technical side of the subject.

What constitutes good service? The answer is somewhat a matter of opinion, but it is generally recognized that a minimum static pressure of 15 lb. per square inch is required at each fixture when no water is flowing at that fixture. This means that the service line and the house plumbing must be so designed that a static pressure of 15 lb. per square inch remains at the highest fixture when the average probable number of other fixtures are in operation. Therefore, the proper design of supply pipes is dependent on ability to forecast the probable demand of all fixtures and knowing the capacity of a combination of service line materials.

There is ample information available in the text books concerning the rates of flow required by all types of fixtures, but no simplified method is available for determining the maximum and probable demand of a group of fixtures. The coincidence of demand of a group of fixtures will vary in different classes of service. It is quite evident that a lavatory in a public rest room will have a more frequent and different duration of demand than one located in a private residence. Reference to proposed studies of this phase of the subject will be made later.

A wealth of information is available concerning capacities of service lines of various materials and hydraulic characteristics of small straight pipes. However, detailed information was still lacking that could be applied to local installations, and therefore it was necessary to conduct a series of pressure loss tests of service line materials, which included corporation cocks, copper, lead, and wrought iron pipe, curb cocks, meters, meter yokes, stop and waste valves, and reamed and unreamed pipe cuts, in sizes up to one inch. No attempt was made to study the larger size service lines inasmuch as their hydraulic characteristics are available in hand-books. May we say that insofar as the tests are similar, the results obtained agree within a small per cent with those obtained by Mr. James E. Gibson of Charleston, S. C.

Procedure of Service Materials Testing

Briefly, the tests were conducted by determining the losses of head with mercury manometers which were connected by small tubes through small orifice openings on either side of the various materials tested. All materials listed are approved by the Indianapolis Water Company and were set up in the test to duplicate the types of installations in actual service. Pressure losses for all material have been recorded for six different rates of flow. Each test was run for ten minutes and manometers observed at one minute intervals. At the conclusion of the ten minute run, the amount of water discharged was weighed and divided by ten to give the rate of flow per minute. The pressure drop readings were averaged for the 10 minute periods. It was decided to test odd lengths of pipe in order to conform as nearly as possible to actual installations but results were interpreted for lengths of 100 ft. All results are plotted on true logarithm paper.

It must be remembered that results obtained indicate flows for new materials and consequently are in variation with any that would be obtained after some of the materials had been in service for periods of time. The progressive changes in the hydraulic characteristics of pipes with service have been thoroughly tested and reported by Messrs. C. M. Fair, M. C. Whipple, and C. Y. Hsiao of Harvard University in the Journal of the New England Water Works Association (Vol. XLIV, No. 4) under the title of "Hydraulic" Service Characteristics of Small Metallic Pipes." The diminishing capacity of steel and wrought iron with age as compared to copper tubing is clearly demonstrated. For this reason it is considered advisable to recommend the use of larger size wrought iron pipe than will be required where copper tubing is used. The present cost of copper and its characteristics are such as to warrant consideration for its use from main to fixture. Stream line fittings for copper tubing were not on the market at the time of the tests but we feel certain that some interesting and favorable data as to pressure loss would have been derived had flows in such fittings been obtained.

Results of the observations are given briefly in table form and are summarized graphically (Fig. 1) by illustrating the pressure losses encountered in typical service installations from main to meter. Curves No. 1 and 2 show what improvement can be made in service capacities with practically no additional cost. That is, by the use of full size tap, straight line meter yokes and stop and waste valves with full water way. Care should always be exercised to eliminate every unnecessary flow restriction, including elbows or bends.

The loss through cast iron ramshorn meter yokes after some length of service, is surprising. An old yoke in an average state of corrosion after some years of service was included in the tests. Flowing 10 gal. per minute, the loss through this yoke without meter was 14.20 lb. per square inch as compared to 3.62 lb. per square inch for a new yoke and 1.30 lb. per equare inch for a straight line yoke. It is desirable to eliminate small cast iron water ways from the design of the service line wherever possible. For new installations where direction of plumbing is convenient, the straight line yoke, which sets in a horizontal run of pipe is most satisfactory. For replacement of the cast iron yoke located in a vertical riser, a yoke with an all copper water way is on the market. In discussing the question of yokes, we call attention to the selection of gaskets. It has been found that rubber gaskets mash out after some service and often decrease the opening in the waterway to an opening as small as ¼ in. A composition washer is now being used with more success by the Indianapolis Water Company.

We dare say that only few manufacturers of stop and waste valves have given careful consideration to pressure loss when designing their valve. They have apparently

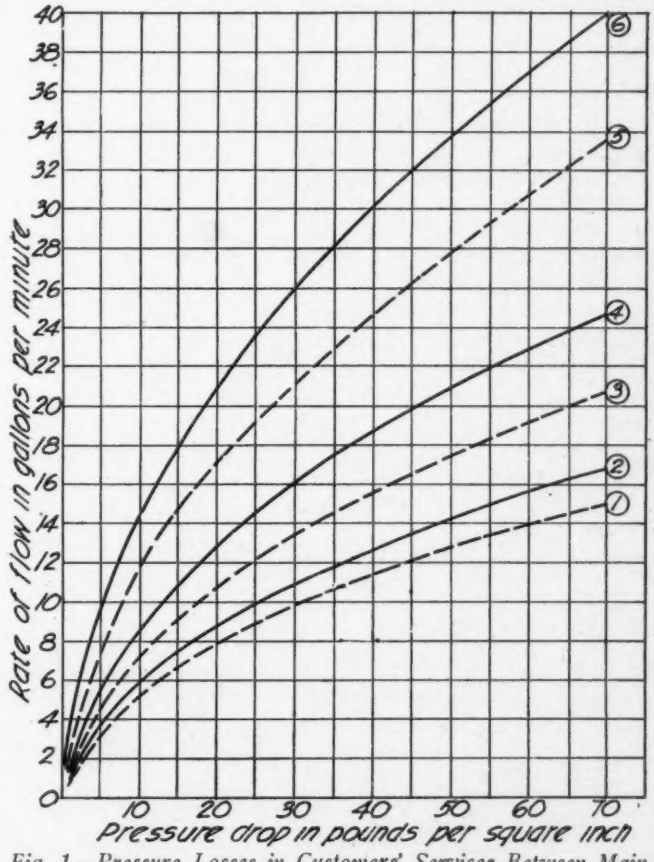

Fig. 1.—Pressure Losses in Customers' Services Between Main and Meter, Indianapolis Water Co.

DESCRIPTION OF MATERIALS

Service No.	Tap size. In.	35-in. pipe—main to property line. Size. In.	Material.	50-in. pipe—Property line to meter. Size. In.	Material.	Meter size. In.	Type yoke.	S.&W. valve size. In.
1...	½	⅝	Lead	¾	W.I.	⅝	Ramshorn	½x¾
2...	⅝	⅝	Lead	¾	W.I.	⅝	Straight	¾
3...	¾	¾	Copper	¾	W.I.	⅝	Straight	¾
4...	¾	¾	Copper	1	W.I.	⅝	Straight	¾
5...	1	1	Copper	1	W.I.	¾	Straight	1
6...	1	1	Copper	1¼	W.I.	¾	Straight	1

PRESSURE LOSSES IN SERVICE LINE MATERIALS, INDIANAPOLIS WATER COMPANY

Description of Material Tested	Pressure Losses in Lbs. per Sq. In. for Rates of Flow in G. P. M.						
Corporation Cocks	5	10	15	20	25	30	35
½-in. with Tail Piece for Lead	1.02	4.05	9.25	....	....	....	....
½-in. with ¾-in. Copper Adaptor	0.59	2.42	5.60	10.02	....	....	....
⅝-in. with ¾-in. Copper Adaptor	0.42	1.65	3.72	6.70	10.05	....	....
¾-in. with ¾-in. Copper Adaptor	0.24	0.95	2.15	3.90	6.10	8.75	....
¾-in. with Tail Piece for Lead	0.20	0.82	1.85	3.35	5.20	7.50	....
1-in. with 1-in. Copper Adaptor	....	0.29	0.65	1.15	1.80	2.55	3.23
Service Pipes							
⅝-in. Lead 35 ft. Long	3.68	12.25	28.00	....	....	....	....
¾-in. Lead 35 ft. Long	1.66	5.53	10.85	18.55	28.12	....	....
1-in. Lead 35 ft. Long	0.48	1.57	3.15	5.08	7.52	10.05	12.95
¾-in. Copper 35 ft. Long	1.51	5.08	10.32	16.80	26.37	....	....
1-in. Copper 35 ft. Long	0.39	1.32	2.81	4.52	6.69	9.25	11.90
½-in. Galv. W. I. 50 ft. Long	5.03	18.50	39.50	....	....	....	....
¾-in. Galv. W. I. 50 ft. Long	1.55	5.50	11.75	19.95	30.00	....	....
1-in. Galv. W. I. 50 ft. Long	0.45	1.50	3.10	5.10	7.60	10.50	13.75
½-in. Galv. W. I. 50 ft. Long with 12 Joints, Cuts Not Reamed	7.90	28.75	....	....	....	....	....
½-in. Galv. W. I. 50 ft. Long with 12 Joints, Cuts Reamed	5.95	20.25	....	....	....	....	....
Curb Stops							
¾-in. for Lead Service	0.21	0.82	1.80	3.10	5.00	....	....
¾-in. for Copper Service	0.12	0.48	1.09	1.95	3.02	....	....
1-in. for Lead Service	....	0.10	0.23	0.41	0.65	0.92	1.25
1-in. for Lead Service	....	....	0.13	0.23	0.37	0.53	0.75
Yokes							
⅝-in. Ramshorn (New)	0.95	5.62	8.00	....	....	....	....
⅝-in. Ramshorn (Old)	3.62	14.20	31.00	....	....	....	....
¾-in. Ramshorn	0.33	1.30	2.75	4.75	7.25	10.25	....
⅝-in. Straight Line	0.28	1.10	2.50	4.50	6.90	10.00	....
Stop and Waste Valves							
½-in x ¾-in. Compression Valve	1.70	6.75	15.00	....	....	....	....
⅝-in. x ¾-in. Compression Valve	0.87	3.15	7.00	....	....	....	....
¾-in. x ¾-in. Compression Valve	0.51	2.05	4.55	8.00	....	....	....
1-in. x 1-in. Compression Valve	0.31	1.31	2.95	5.30	8.25	11.50	16.0

paid most attention to design as related to cost of production. For instance, there are quite a few ¾ in. valves on the market which have only ½ or ⅝ in. waterways. Flowing 10 gal. per minute through ½ in. by ¾ in., ⅝ in. by ¾ in., and a full ¾ in. valve, pressure losses of 6.75, 3.15, and 2.05 lb. per square inch respectively were recorded. It is well for the utility operator to restrict the use of valves to those of approved design whenever possible.

Every well prepared plumbing specification calls for the reaming of all pipes to insure that they will deliver their full capacity. Results confirm the need of that specification. When flowing 10 gal. per minute through 50 ft. of ½ in. galvanized wrought iron pipe with 12 joints cut in that length the pressure loss was reduced from 28.75 lb. per square inch to 20.25, by reaming the cuts. Also the incrustation of increased joints cuts down the area of the pipe at that point materially in a short time.

The builder is liable to and often does lose sight of the importance of this item in accepting the lowest bid for the plumbing work. Control of installation of house plumbing is beyond the jurisdiction of the utility operator and he can but emphasize its importance to all parties concerned.

The selection of meters also has a bearing on this subject but we will limit the discussion to the comment that we feel there is a decided tendency to oversize the meter. Sight should not be lost of the importance of accurate registration.

It is the practice in Indianapolis to install the service line between main and property line in advance of permanent street improvements. In order to guarantee satisfactory service to the future customer it is desirable to forecast the type of dwellings that will be built in districts. That is, it is necessary to zone the city and install services of sizes in keeping with the estimates on types of future development. As every utility has a different problem, no definite recommendations are considered necessary. Curves 1 to 6 on the graph are given to show relative capacities of typical services. Allowing a 20 lb. per square inch pressure drop between main and meter, good service may be obtained for maximum flows of 7.8

Fig. 2.—Cover of Educational Leaflet

gal. per minute for service No. 1, 8.7 for No. 2, 10.7 for No. 3, 12.8 for No. 4, 17 for No. 5, and 20.9 for No. 6. The above designs are typical and must be varied to suit local conditions such as distribution pressure, length of service, and other factors.

In order to acquaint its customers with causes for unsatisfactory service the Indianapolis Water Company has recently prepared a small educational leaflet. See Fig. 2. This will be distributed to architects, builders, plumbers, persons inquiring about pressure troubles, and those building new homes. It is hoped that through this and other avenues we may help customers benefit by studies that have been made.

Studies completed to date represent only the beginning of an effort to secure desired information relative to the subject. It has been recently learned that the Neptune Meter Company is considering the manufacture of a recording register for water meters. We feel that such a device is an important and needed step in the future development of these studies. Such a register installed with a meter in various types of services will tell a graphic story of their demands, and it is hoped that with a collection of such data a practical ratio between demand and number of fixtures can be determined. The instrument would also prove advantageous in cases where the customer encounters poor pressure during certain peak consumption hours or at other random periods. Indications are that the register will be on the market soon and it should be of considerable help to plant operators.

Not alone do we consider the angles of satisfactory service to consumers, responsibility or obligation, and increasing revenue. It is also advisable that Water Companies make strong efforts to supply the growing demand for water through elimination of avoidable pressure losses in supply lines because the only other solution to the matter is the maintenance of greater pressure in the general distribution system and that results in higher operating costs which the well managed organization is endeavoring to reduce.

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Electrical Coating of Interior of Mains with Bitumen

The problem of recoating pipes after cleaning operations has apparently been solved through the development of an English process for coating the pipe in situ.

The solution of the problem was found to be electrodeposition of bitumen from an aqueous medium where it existed as a colloid suspension. Under the appropriate conditions of voltage and solution concentration the deposition is rapid and completely adherent. The coating will immediately withstand flushing after application, when the water may be turned on again immediately the pipe has been pieced up.

The general procedure is to scrape a 200 yd. length one day and to recoat it the next day, while the next length ahead is being scraped. The solution is pumped into the length under treatment until it is completely filled, and an insulated electrode is drawn through in stages equal to its own length, the pipe itself forming the other electrode. Electric current is supplied from portable generators. Bitumen being an insulator, the current ceases when all exposed iron under the influence of the electrode is thoroughly coated. This is shown on the ammeter, and the electrode is then drawn on a distance equal to its own length. Positive control is thus assured by the instruments upon ground level. Good old coating left on the pipe will insulate it at that point and will not be coated over, but all exposed iron, even if rusty, will be coated. The solution being an aqueous one, is perfectly miscible in water, and standing pools of water in the pipe merely dilute it slightly. After the complete passage of the electrode through the pipe, the solution is pumped out back into tanks, any slight surplus flushed off, and the main may then be put into service. House services are unaffected if the stop-taps are kept shut and are efficient. If no stop-taps exist, no trouble is experienced provided that all draw-taps are kept shut until the service is restored.

The net result of the recoating process is that a supply of clear water is assured indefinitely, if such existed ab initio, and that within the limits of their experience the formation of fresh deposits is very much retarded. Pipes coated for the Manchester Corporation have been cut two years afterwards, when the condition of the new coating was found to be perfect and no new deposits were discernible.

Questions are frequently asked about the life of the coating in actual service. This cannot be answered until after the lapse of many years. Accelerated corrosion tests in acid solution are always misleading and cannot be correlated with tests under normal working conditions. However, tests with half normal sulphuric and hydrochloric acids over periods of months have failed to show any weakness in the coating, but as is mentioned above, tests of this nature are always unreliable.

Reports from consulting and county analysts show that the coating is absolutely harmless, tasteless and odorless, and without effect on the water, which is to be expected considering the inert nature of bitumen, the ideal pipe coating.

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H. P. Eddy and R. F. Goudy to Lecture Before the Institute of Government, at University of Southern California

Ray F. Goudy, Sanitary Engineer with the department of water and power, Los Angeles, and vice-president, California section of the American Water Works Association, will lead the section in water supply and sanitary engineering at the fifth annual Institute of Government to be held at the University of Southern California from June 13 to June 17.

Mr. Goudy will give three lectures at the institute and will preside at the round table discussion and reading of papers following the main lecture at each afternoon session.

Harrison P. Eddy, Consulting Engineer of Boston, also will lecture before the sanitary engineers on June 15 and 17. Mr. Eddy is author of several works on drainage and has been consulting engineer on sewer drainage for the cities of Boston, Chicago, New York, Louisville, Milwaukee, Pittsburgh and Cincinnati.

Peter Diederich, Superintendent of Water and Power for Glendale, California, is chairman of the water supply and sanitary engineering committee which has arranged the program for this section of the institute in cooperation with university authorities.

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STATE AND MUNICIPAL BOND ELECTION RESULTS DURING MAY—New state and municipal bond authorizations by the taxpayers of 36 communities located in 21 states totaled $10,169,389 during May, according to *The Daily Bond Buyer,* of New York. A few of the larger items approved last month were $6,500,000 San Francisco, Cal.; $1,000,000 Multnomah Co., Ore.; $1,000,000 Portland, Ore., and $750,000 New Orleans, La.

NEW ENGLAND SEWAGE WORKS ASSOCIATION MEETING

THE Fourth Annual Meeting of the New England Sewage Works Association was held at the Hotel Bradford in Boston on April 25, 1932. President Warren J. Scott of Hartford, Conn., presided. One hundred and four members and guests registered.

Morning Session—Papers

The paper, **Industrial Wastes in Relation to Sewage Treatment,** by **Stuart E. Coburn** of Boston, was presented by **A. L. Fales** of Boston.

The effects of certain types of industrial wastes on sewers and sewage treatment plant processes were outlined. Examples of sewer disintegration, clogging of filters and scum formation in settling and sludge digestion tanks were cited together with regulations adopted at Worcester, Mass., and Fostoria, O., prohibiting the discharge into sewers of certain wastes detrimental to the sewers, pumps or treatment plant processes.

The policy of adopting arbitrary rules or regulations entirely prohibiting certain wastes from the sewers was not recommended. Requirements for proper treatment if necessary before discharge into the system was considered a better policy. The probable effect of the industrial wastes should be determined and the sewerage system and treatment plant designed accordingly.

The South Essex, Mass., Sewerage System was described by **Bayard F. Snow** of Boston. This system serves the South Essex Sewerage District, comprising the cities of Salem, Peabody and Beverly and the town of Danvers. The crude sewage from a population of about 100,000 is discharged into Salem Harbor, through a 54 in. outfall, 8,000 feet long.

Allocation of cost between the various municipalities and institutions served by the system was on the following basis: ⅔ on sewage flow and ⅓ on tax valuations.

A particularly interesting feature of the paper was the description of clogging of sewers due to industrial wastes containing lime which had come principally from tanneries. Large quantities of spent lime solution upon mixing with sewage containing CO_2 had been precipitated as calcium carbonate. In one instance the scale formation in a 30-in. sewer had reduced its capacity to that of an 18-in. sewer.

The New Canaan, Conn., Sewage Treatment Plant was described by **J. G. Albertson** of T. H. Bowe, Consulting Engineers, New York City.

Mr. Albertson said that the new activated sludge treatment plant at New Canaan, Conn., had been completed in 1931, to replace an old plant consisting of septic tanks and sand filters. The new plant includes primary tanks, aeration tanks which may be operated in parallel or in series with aeration provided mechanically by partly submerged paddle wheels along one side of the tanks, secondary tanks, sand filters, a laboratory and chlorination facilities. He said that the old septic tanks had been converted into sludge digestion tanks. New Canaan with a population of 2,300 had a sewage flow of one-half million gallons per day. It is a residential town with no industrial wastes, the relatively large flow being caused by infiltration into the sewers.

Round Table Discussion

The afternoon was taken up with Round Table Discussion.

Industrial Wastes: opened by **H. W. Clark,** Chief Chemist, Massachusetts Department of Health.

Mr. Clark summarized the studies in South Essex district leading to the carbonation of caustic lime wastes to prevent deposition in the sewers and referred members to his article published in the February issue of WATER WORKS AND SEWERAGE for details of the process developed.

Mr. Wise, of Connecticut, described a laundry waste treatment plant using lime and copperas constructed at a Connecticut institution to protect the Imhoff tank and filters.

Separate Sludge Digestion: opened by **Prof. G. M. Fair** of Boston.

Mr. Fair reviewed modern ideas concerning sludge digestion practice. The present trend, he said, is towards continuous or stage digestion of sludge at temperatures of 80 to 100° F. and dewatering on vacuum filters and incineration of the sludge cake. Stirring of sludge does not appear to be particularly beneficial and he thought would result in under digested sludge being drawn off with the digested sludge.

Screens were discussed by **Mr. Flood** of Boston, who enumerated the various types of screens and their application and place in sewage treatment plants.

Removal of Oil and Grease was the topic handled by **Mr. Allen,** of Fitchburg, who said that the problem of waste oil in the sewage at Fitchburg had been successfully handled by adoption of regulations prohibiting the discharge, posting of notices in all garages and other sources. They had had the cooperation of the people responsible for discharging oil into the sewers.

Operation of Small Treatment Plants was a subject assigned **Chas. L. Pool,** Chief Engineer of the Rhode Island Department of Health. In Mr. Pool's absence a joint paper by himself and Mr. Pool—**"Safety First in Sewage Plant Operation"**—was read by **E. C. Johnson,** Engineer, of the Rhode Island Board of Purification of Waters, Providence, R. I.

The possible hazards to be met in operating modern sewage treatment works were reviewed. These included dangers from hydrogen sulphide and chlorine poisoning, gas leaks in sewers, accidents and explosion of sludge gas. Hydrogen sulphide had caused more deaths than was generally known and was the most deadly of the sewage gases.* The use of canary birds or mice as indicators of atmospheres dangerous to man might well be employed at sewage works and in sewers. First aid methods of resuscitation should be understood and a gas mask should

*In this connection the reader is referred to the discussion of "Lethal Gas" on the editorial page of this issue.

be a part of plant equipment. The paper also discussed the avoidance of needless exposure of operators to infection through open wounds or sores and stated that clothing worn on duty should not be worn home, to possibly infect small children. The matter of considering hazards at sewage works should be taken into greater consideration by engineers when plants are designed and all possible gas pockets should be eliminated. The authors made an excellent suggestion, to the effect that operators should avoid danger spots when alone at the plant and men working in tanks, manholes or pits should be watched closely for signs of distress.

Edward Wright, Engineer, of the Massachusetts State Department of Health, reported on his **Observations of American and Canadian Sewage Treatment Plants."** He had made a recent trip of inspection to sewage treatment plants in New York, New Jersey, Ohio and Canada and commented upon interesting features observed.

Evening Meeting

An innovation at the dinner, attended by 80, was the musical entertainment.

Following the dinner, **Roy S. Lanphear** of Worcester summarized the report of the Committee on Sewage Sampling, and said that copies of the report will be mailed to the members of the association.

Prof. John W. M. Bunker, Department of Biology and Public Health, Massachusetts Institute of Technology, addressed the association on **"Stream Pollution and Self-Purification"** processes and illustrated his talk with micro-projection of living organisms on the screen.

Business Meeting

Two amendments to the constitution were adopted.

Result of election of officers:

President, Roy S. Lanphear of Worcester, Mass.

Vice President, Prof. Gordon M. Fair of Boston, Mass.

Sec'y-Treas., F. Wellington Gilcreas of Boston, Mass.

Executive Committee: Warren J. Scott of Hartford, Conn.; Frederick C. Williams of Pawtucket, R. I.

Manufacturers' Exhibit

The following firms exhibited equipment or materials: The Dorr Company, Lord and Burnham, Link-Belt Company, Wallace and Tiernan Company, The Norton Company and the Pacific Flush Tank Company.

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California Sewage Works Association Meeting

ABOUT 100 members of the California Sewage Works Association, and guests, assembled on May 20th at the Yosemite Park activated sludge plant located near Bridal Veil Falls. The plant consists of a plain hopper bottom settling tank; 4 aeration units equipped with Norton plates (air being furnished by 2 G. E. centrifugal blowers), and designed for Manchester type aeration—one unit can be used for reaeration; 2 Dorr clarifiers in series, the second serving also as a chlorine contact and final settling tank; an automatic Wallace & Tiernan chlorinator for regular use, with a portable machine for standby emergency service; separate sludge digestion tanks with gas collection and heating but no mechanical stirring; a sludge thickening tank for raw or activated sludge; and a glass covered sludge drying bed.

The plant is well arranged, neatly kept and aroused favorable comment from the members. Particular comment was heard on the use of continuous streams of effluent from the two clarifiers for sampling at a table similar to that at a water filter plant, and a vacuum gauge with colored liquid, at the same table, to indicate the chlorine feed at any given time. A float gage on the effluent weir gives readings of sewage flow leaving the plant.

The Meeting

A paper describing design and operation of the **"Activated Sludge Sewage Treatment Plant in Yosemite National Park,"** was read by **Russell C. White,** operator. Discussion following this paper included pertinent comments on (a) Griffith Park Experimental Station, Los Angeles, by **S. M. Bennett,** Chief Operator; (b) Activated Sludge Sewage Treatment Plant, Lodi, by **Fred W. Post**, Superintendent; (c) Activated Sludge Sewage Treatment Plant, Pasadena, by **Alfred W. Wyman,** Superintendent; (d) Activated Sludge Sewage Treatment Plant, Salinas, by **T. R. Haseltine**; (e) Activated Sludge Sewage Treatment Plant, Los Angeles Sanitation District, by **A. P. Banta**; Activated Sludge Treatment Plant, Grand Canyon National Park, Grand Canyon, Arizona, by **Hilliard Hall,** Operator, (read by H. B. Hommon).

W. C. Roberts reported that he had just returned from Phoenix, Ariz., and that excellent results were being obtained with paddle aeration supplementing diffused air, using about 0.25 cu. ft. of free air per gallon.

The symposium, **"Unusual Experiences in the Operation of Sewer Systems,"** by **F. A. Batty,** Los Angeles; **F. D. Bowlus,** Los Angeles County; **J. C. Albers,** Glendale; **C. M. Hoskinson,** Sacramento; **T. F. Eastman,** Oakland; and **W. F. Rantsma,** Fresno, brought forth many interesting and instructive observations. An entertaining talk on **"Political Experiences"** was given by **S. H. Davis** of Glendale. **D. E. Perry** of **San Anselmo** asked for information on per capita cost of sewerage and sewage disposal at various places and was given the information in a few instances.

Outdoor Barbecue

One hundred and eight members and guests attended the outdoor barbecue at Indian Caves in the evening. President Allen introduced H. B. Hommon, who introduced various park officials who contributed to making the meeting a success. Dr. D. Tresidder, general manager of the Yosemite Park and Curry Company, referred to the sewage disposal problem as having been "solved" about every ten years in the history of the Valley and expressed the hope that the new plant would prove the final solution.

Bert Harwell, Park Naturalist, spoke on the formation of Yosemite Valley. The famous spectacle of the "Fire-Falls" from Glacier Point was especially arranged for the meeting through the courtesy of park officials and was a fitting climax to an eventful day and evening.

The Second Day

Professor **C. G. Hyde,** as Chairman, read the report of the Committee of Award of Merit for 1931, which decided in favor of Pomona, largely because of the development of revenues from sewage and also for its excellent records. Honorable mention was accorded to the plant at Escondido.

The Resolutions Committee presented written resolutions in memory of two deceased members, Philip Schuyler of San Francisco and Andrew M. Jensen of Fresno.

The Committee then paid a high tribute to Professor Charles Gilman Hyde for his many years of pioneer work in sanitary engineering and teaching in the West.

Prof. Hyde responded briefly by telling of the satisfaction he had of seeing his former students at work in the sanitary engineering field, which he said was the greatest satisfaction men like Prof. Reynolds at Stanford and himself could get from their teaching.

Alva J. Smith spoke briefly of the progress in sanitation in California during the ten years since he came to the state.

Papers were presented as follows: (1) Activated Sludge Sewage Treatment Plant at Folsom Prison, by L. E. Rushton; (2) Odor Control at the Whittier Sewage Treatment Plant, by Alva Smith; (3-a) Digestion of Bar Screenings, by A. M. Rawn, Discussed by F. A. Batty and T. R. Haseltine. (3-b) Digestion of Garbage in Beccari Cells with Analogies to Sludge Digestion Problems, by Chas. Gilman Hyde. Discussed by J. C. Albers and A. M. Kivari. (4) Improvements at Sewer Farm at Tulare, by W. M. Brown, City Manager; (5) New Thoughts in Sedimentation of Sewage, by Chester A. Smith; (6) New Thoughts in Sludge Digestion and Disposal, by R. F. Goudey.

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Progress Report of the Boiler Feed Water Studies Committee*

The Committee, in April 1931, completed negotiations whereby a fellowship was established at the Ohio State University under the direction of Professor C. W. Foulk, to continue the studies on priming and foaming of boiler waters. Prof. Foulk presented an interim report of the results of his work at the Boiler Feed Water Studies session held during the annual meeting of the A. S. M. E. in New York. The work is being continued and it is anticipated that a second progress report will be released this year.

Subcommittee No. 8 on the Standardization of Water Analysis Methods has been reorganized under the chairmanship of Mr. C. H. Fellows and close contact has been established with similar groups in the American Society for Testing Materials, the National Electric Light Association, and this Association and others. To facilitate the work of formulating standard test methods the Committee has established a fellowship at the University of Michigan. Mr. Fellows presented an interim report at the Boiler Feed Water Studies meeting held during the annual meeting of the A. S. M. E. in New York. His report to be presented here, is the result of further research.

The data which have been assembled as a result of these two research studies has added materially to the technical knowledge, so essential for the successful control and operation of boiler feedwater purification systems and the effect of such water in steam generating equipment. The knowledge gained through these activities should furnish a fund of information for inclusion in the forthcoming Water Works Practice Manual and should be invaluable in the revision of Standard Methods of Water Analyses.

The Finance Committee has secured during the past two years, a research fund of about $3,300 and there has been secured from the Engineering Foundation an additional grant of $3,000 to continue the work of these two Committees during the coming year.

The fund available is insufficient to distribute in full copies of the research reports. This Association (the A. W. W. A.) has a representation on the Executive Committee of the Boiler Feed Water Studies Committee, so that the full research reports will be available for publication in the Journal.

Close contact has been maintained between the chairman of the Boiler Feed Water Studies Committee and the Association Committee on Standard Methods and the results of the research studies pertaining to water analyses applicable for boiler feedwater and industrial uses have been made available to that Committee.

The results of the research program are proving invaluable in the collection of fundamental and basic data relative to the design and operation of boiler feedwater conditioning systems and allied problems.

*Presented at the Memphis convention of the A. W. W. A., May 3, 1932, by J. T. Powell, Chairman. 213 St. Paul Place, Baltimore, Md.

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The Lingo of the Chemist*

The Chemist at a water plant
Is a funny guy by jingo—
Has a crazy way of talking
In a strange and private lingo.

Water isn't water
That's the first thing you must know
When the Chemist speaks of water
He will call it H_2O.

He gets a colored water
And goes almost crazy—See!
As he hollers to his strikers
Start the $FeCl_3$.

Get the NH_3 agoing,
Now then get a move on you
And add more $CaCO_3$,
Jack up the Cl_2.

What? You haven't any NH_3!
You bloomin' nuts—I've said before
I hate to use the substitute
The $(NH_4)_2SO_4$.

What!—the pH is declining?
There is iron that you can see;
Well you blighter you get busy
Add Na_2CO_3.

There's the telephone a ringing,
Gosh but we are in a fix;
Super' says the water's lousy,
And is filled with Crenethrix.

Never saw the like before,
I will sure catch Hell;
Come, you guys, do something
With the NH_2Cl.

I'd like to change that crazy talk—
But then I'm not a meddler;
Still I'm glad I'm not a Chemist—
But am just a blooming peddler!

—Bill Orchard.

*As read at the Annual Water Purification Dinner, A. W. W. A. Convention, Memphis, Tenn., by Wm. J. Orchard of W. & T. Co. as master of ceremonies.

HIGH-LIGHTS OF SEWAGE TREATMENT IN EUROPE

By EDMUND B. BESSELIEVRE
Sanitary Engineer, The Dorr Company, Inc.

(PART 2)*

THE trend in Germany, as indicated by the most recently constructed plants at Stahnsdorf, Wassmannsdorf, Leipzig, Neumunster, Possneck, etc., is toward almost as complete use of mechanical equipment as is practiced in this country. The results of such installations as the mechanically-cleaned bar screens at Stahnsdorf, Wassmannsdorf, Leipzig, Neumunster, etc., the detritors at Leipzig and Stahnsdorf, mechanically-cleaned clarifiers at Stahnsdorf, Neumunster, etc., have convinced the German engineers of the value of mechanical operations to "iron out" the rough spots of manual operation, and this despite the lower wage scale for labor in Germany.

*Part 1, dealing with observations in England and Holland, appeared in the May issue of Water Works and Sewerage.

Fig. 1.—Stahnsdorf Plant of Berlin Sewage Treatment Works.

Without doubt one of the most interesting plants to see in Germany is at Stahnsdorf, in Berlin. This is an entirely new plant, designed to treat a daily average

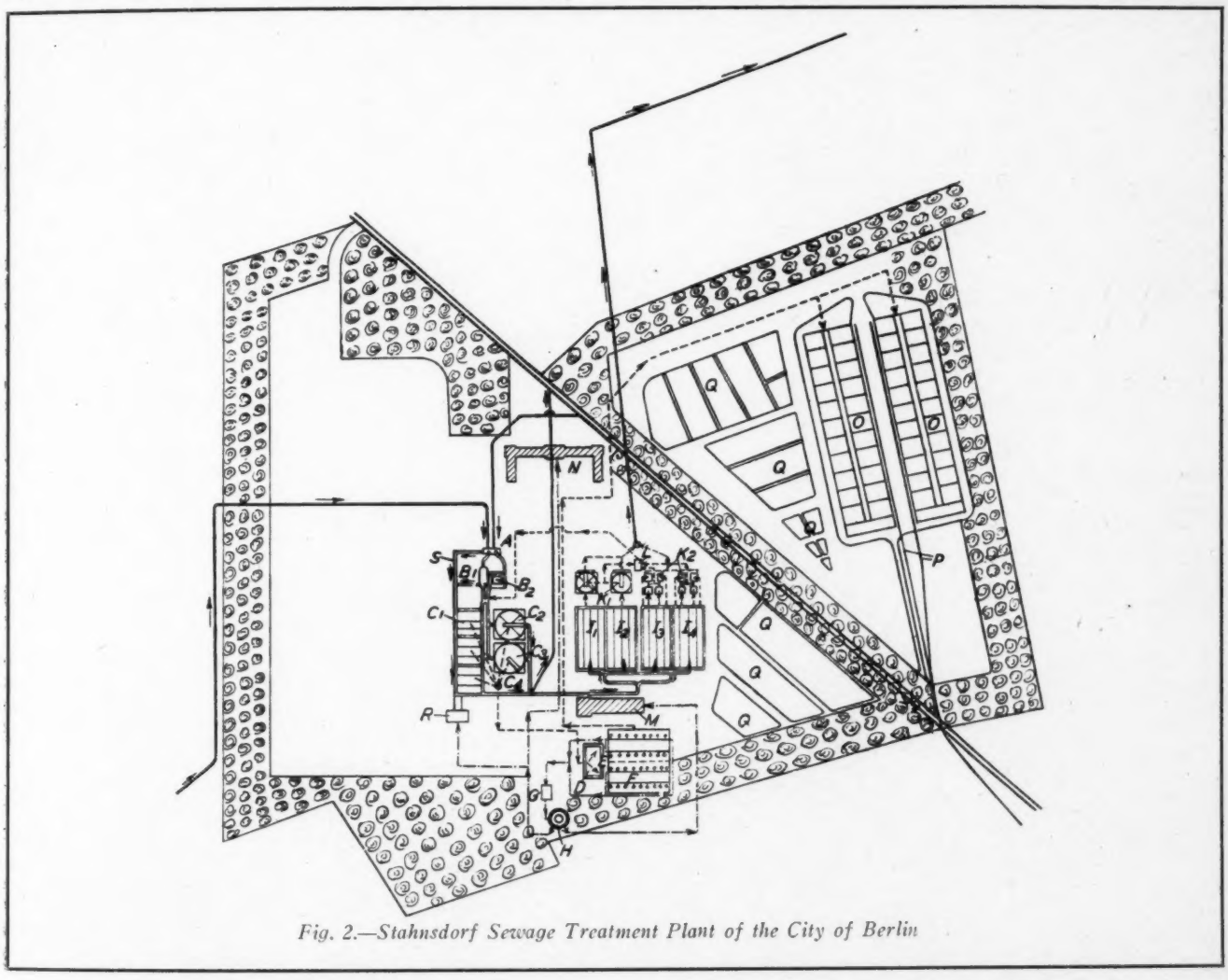


Fig. 2.—Stahnsdorf Sewage Treatment Plant of the City of Berlin

A = Mechanically cleaned bar screens.
B_1 = Plain grit chamber.
B_2 = Dorr Detritor.
C_1 = Mieder type clarifier for preliminary sedimentation.
C_2 = Dorr type clarifier for preliminary sedimentation.
C_3 = Dorr traction clarifier for preliminary sedimentation.
C_4 = Sludge line.
D = Preliminary sludge digestion tanks.
E = Sludge heating plant.
F = Digestion tanks.
G = Gas purification apparatus.
H = Gas storage tank (3,000 cu. m.).
I_1–I_4 = Aeration tanks.
K_1 = Dorr clarifiers for final sedimentation.
K_2 = Dortmund tanks for final sedimentation.
L = Activated sludge pumps.
M = Power house and administration building.
N = Operator's living quarters.
O = Sludge drying beds.
P = Railroad siding for sludge handling.
Q = Fish ponds.
R = Screenings incinerator.
S = Conveyor belt for screenings and grit.
Sewage ————————
Sludge – – – – – – – – – – – –
Gas ——. ——. ——. ——. ——.

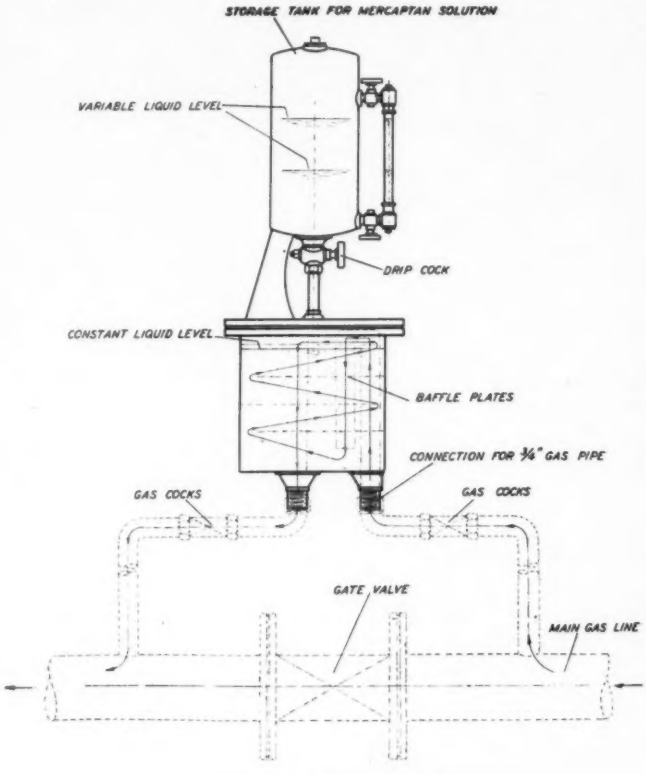
volume of 26.5 m.g.d., (U. S.), and is a complete activated sludge plant. This is regarded as a demonstration plant leading to the development of methods for future construction in Berlin. It, therefore, comprises different types of units for each successive treatment step; for instance, there are two types of mechanically-cleaned bar screens, two types of grit removal—one of the hopper bottom channel type, with dredge, and the other a Dorr Detritor—three types of mechanically-cleaned sedimentation tanks—one a Dorr Traction Clarifier, one other of the same general type, and a set of tanks with the mechanism traveling lengthwise of the tanks. It is planned to split the normal flow to these three units equally, so that each will get the same volume and character of sewage. Following the primary sedimentation units, there are four sets of aeration tanks, the first two being of the straight diffusion type with three rows of plates, with individual control pipes to each individual plate; then a set with revolving paddles and diffused air combination, and a fourth set with diffusion. Following these aeration units are two Dorr Traction Clarifiers and two settling tanks of the Dortmund type. The sludge from the final tanks will be returned to the primary tanks for consolidation with the primary sludge, and the combined sludge pumped to the digestion tank. The sludge will first be put through a concentration tank and thence into the closed digester, which will be provided with means for circulating the sludge and with gas collection facilities. The gas, as described before, will be utilized in the gas engines to produce necessary power. The administration building, Fig. 1, which is a part of the power house, is provided with ample facilities for the usual analytical and test work. The grounds are beautifully landscaped, and houses of artistic design are provided for the operators and their families. A full description of this plant, with illustrations of the various units, was recently published.** The plan view (shown as Fig. 2) gives an idea of the design and arrangements of this plant.

In Germany, the plants that are using digester gas or gas from the capped vents of the Emscher tanks are almost too numerous to mention. Certainly, all of the latest installations have gone into this phase of utilization with much enthusiasm, the largest installation that I saw being that at the new Stahnsdorf plant at Berlin. In the plants operated under the jurisdiction of the Ruhrverband, the following plants are run entirely with power developed from the captured gas: Iserlohn and Hattingen, and in the Emschergenossenschaft the large plant at Essen-Nord. The plant at Essen-Fronhausen and that at Gelsenkirchen produce the power required to run the plants. This not only includes the power required to run such units as sludge pumps and clarifiers, but also the blowers and compressors for aeration, and to turn the paddles of the aeration system used in the Ruhrverband (as developed by Dr. Imhoff), and for other necessary functions around the plant.

The method of operation at Iserlohn is particularly interesting. Instead of developing electric current to subsequently run motors, the gas engine is connected to a line shaft and the plant is so laid out that all of the mechanisms for the Tauchkorper are operated from this line shaft by means of shafts passing through the walls.

At Essen-Rellinghausen No. 1, which is the large plant at Essen, of which a very excellent and complete description has recently been published,† the gas developed in the capped Emscher tanks and from the later digestion tanks is discharged directly into the large 30,000 cu. ft. gas holder of the local gas company, at a price of 3.5 pfennigs per cubic meter, or 24.7 ct. per 1,000 cu. ft. At this plant, while no power actually is generated from the digestion tank gas, it has been shown that there is sufficient gas produced daily to generate all the power required to run the mechanisms of the various units in the plant.

At the Stahnsdorf plant (Berlin), described earlier, the power plant consists of three engines of German make, two of 500 hp., convertible to 750 hp. by changing cylinders, and one of 750 hp., beautifully housed in a power house which would be a creditable installation to any public utility. (See Fig. 1.) The gas to run these engines will be obtained from closed tanks, and



GAS ODORIZING DEVICE.

Fig. 3.—Gas Odorizing Device, Used in Germany to Add Mercaptans to Sludge Gas to Produce a Warning Odor

sufficient power is expected to provide the power necessary to operate the various units and provide lighting. At Wassmannsdorf (Berlin) the gas captured from capped Emscher tanks is used to operate an engine of 750 hp., housed in an attractive building of modernistic style of architecture. These engines are of German manufacture, and the guaranteed rating is the same as for the English engines, viz.: 20 cu. ft. of 625 B.T.U. gas per horsepower hour. When one considers the low gas production of the plants mentioned, which, from published data is as follows:

	Cubic Feet per Capita per Day
Essen-Rellinghausen	0.56
Iserlohn	0.43
Hattingen	0.55
Essen Nord	0.41
Essen Fronhausen	0.49
Gelsenkirchen Nord	0.26

and it is realized that sufficient power is produced at that rate to run the plant machinery, there is justification for the belief that, with an engine providing the same

**Das Abwasser Grosklarwerk Berlin-Stahnsdorf—F. Langbein—Zeitschrift des Vereines Deutscher Ingenieur. Sept. 27, 1930.

†Die Klaranlage Essen-Rellinghausen und die Auswirkung ihrer letzten Erweiterung, Franz Fries, Gesundheits-Ingenieur, 1931, Heft 45 und 46.

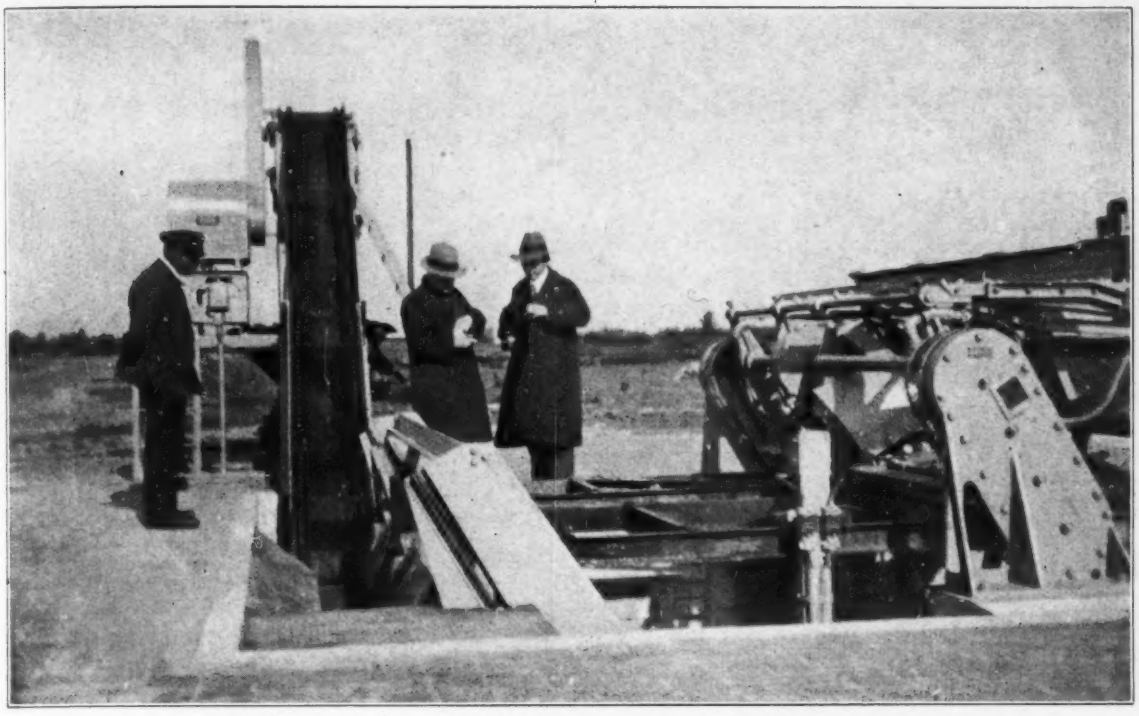


Fig. 4.—Bifurcated Dorrco Bar Screen With Screenings Conveyor at Sewage Works, Neumunster, Germany

ratio of output of power to input of gas, with the greater amounts of gas produced in our most modern plants in the the U. S., a few of which are as follows:

Antigo, Wis.	1.29
Chico, Calif.	1.10
DeKalb, Ill.	1.30
Elyria, Ohio	0.77
Grand Rapids, Mich.	0.95
Middletown, N. Y.	0.80
Toronto, Ont. (North Toronto)	1.1
Waukesha, Wis.	0.70

it will not be difficult to provide all the power required on any installation. This, of course, assumes the adoption of the principle of using the cooling water and exhaust heat to provide the heat units to maintain the digesters at the proper temperature. Undoubtedly, power companies will attempt to combat the growth of this principle, but there is no reason why a city should not produce its own power from its own waste materials, provided it does not go into the market and sell that power.

As most of our efforts in sewage treatment are expended in the effort to remove the odors from it, the prescription of the German health authorities, which makes it obligatory for users of gas derived from sludge digestion tanks to put a smell into it, is interesting and deserves a little attention. Wherever, in Germany, it is desired to use digester gas for heating purposes or in places where it might escape and be dangerous to persons in the vicinity, it is required that it be "odorized" by the addition of mercaptans. A special apparatus has been designed and is readily obtainable for this purpose. Its cost is small and a supply of 5 kilograms of mercaptan liquid costs only $36.00. This supply lasts a long time, according to experience in Germany, because it is only necessary to use a small quantity of the mercaptan to produce results. The apparatus, a cut of which is shown (Fig. 3), consists of two tanks connected as shown. The upper tank with the level gage contains the mercaptan liquid, which flows through the connecting pipe to the lower tank, in which a constant liquid level is maintained. A small quantity of the gas to be odorized is led spirally through the liquid of the lower tank by means of deflectors, and then this odorized gas is mixed with the main supply.

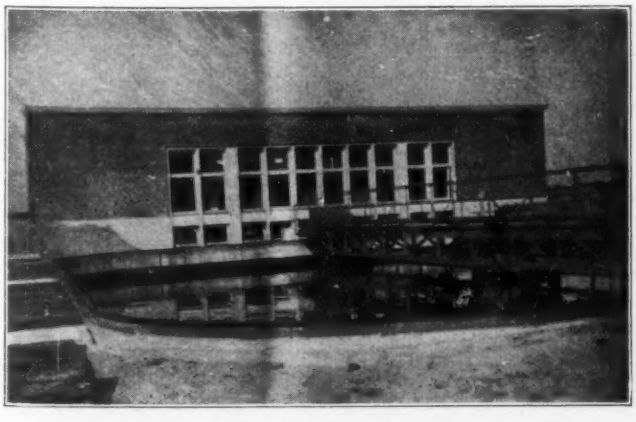


Fig. 5.—Traction Clarifier Handling Crude Sewage at Neumunster

The Neumunster Plant

At Neumunster, in Schleswig-Holstein, Germany, a new plant was built and put into operation early in 1931, under the supervision of Baurat Schmidt, of that city. This is an unusual plant, as it not only treats the sewage of the city of Neumunster, but also handles the tannery wastes which are a large part of the total daily flow. The average daily amount of sewage is 4.25 m.g.d., and the tannery waste proportion is approximately 1 m.g.d. The wastes and sewage are carried to the site of the plant in separate pipes and kept entirely separate in channels until after passing the mechanically-cleaned bar screen. This screen is a double unit, with rakes operating on the bars in each channel, the bars of the rack in the sewage channel being spaced 1 in. in the clear and those in the tannery waste channel being spaced ½ in. in the clear. Both rakes operate on the same mechanism and are operated periodically by timed control. The screenings are raked in a trough carrying a flight conveyor with steel belt, and for a period of a few minutes

after three rakings of the screens, the conveyor runs, carrying the screenings to the top of the conveyor and discharging them directly into a car. (See Fig. 4.) Immediately following the two bar racks, the two flows unite and pass into a clarifier, where a minimum of one hour and a half to a maximum of three hours' sedimentation is provided. The effluent from this tank (Fig. 5) is discharged into the local stream. Sludge is drawn from the clarifier into pneumatic ejectors and discharged to sludge-drying beds a few feet away. This sludge, when dried, is cut into small squares and removed and piled alongside the beds, and is taken away by local farmers.

At most of the German plants considerable attention is being given to the design of buildings for the plants and living quarters for the attendants. This, naturally, adds to the attractiveness of the plant and follows closely along the modern American idea of making sewage plants attractive to the eye, to remove the stigma of their purpose.

The conclusion one draws, after a visit to England and Germany, now, is that they are seeing more nearly eye to eye with us than at any other time, when it comes to methods of treating sewage, and are beginning to realize that many of the so-called differences between American and Europe sewage are not serious, and the same methods, with necessary modifications, may be employed on both.

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Water Works Intake Clogged by Needle Ice

Difficulties resulting from needle ice clogging the intake of the water works of Elyria, O., were described by N. J. Hamason, Superintendent of Filtration, in a report presented at the 10th annual Ohio Conference on Water Purification.

The intake is a 24-in. c. i. pipe extending from a shore well to a submerged crib about 1500 ft. from the shore. The crib is made of wood and weighted down by stones. The pipe is connected into a compartment about 4 ft. square in the center of the crib. This compartment is covered by a bar screen made of ½ in. x 3 in. bars spaced ½ in. apart. The screen is about 7 ft. above the lake bottom and about 15 ft. below the surface of the water.

When needle ice is present in the lake, it is very apt to collect in such a manner as to clog the intake. The obstruction built up may only diminish the flow slightly or it may practically prevent the flow of any water into the plant. This latter condition has occurred several times. From the fact that no way of dislodging this ice has been found, it is evident that such a situation is very serious. While the longest period through which this condition has held-on is 31 hours, there is nothing to assure that it could not last much longer.

During the 31-hour period that the intake was clogged it became necessary to reduce the high service pressure to a point where water was available only to a few of the more fortunate consumers. This was done to conserve the supply on hand. Considerable difficulty was forced upon some of the industrial plants when the supply to their boilers or cooling appliances was cut off by reduction in pressure.

A number of procedures were suggested for dislodging these ice blocks. Among them are:

1st. Blowing back with water or air.

2nd. Melting the ice by steam or electricity.

3rd. Raking it off the bar screen of the crib.

4th. Installation of a revolving screen.

5th. Installation of an auxiliary pump on the shore with removable intake to pump from the lake near the shore to the suction well of the raw water pumps.

Blowing back with water was tried on two occasions without any noticeable benefit being obtained. The only result was the loss of a considerable volume of pure water. This also conforms to results reported from other lake plants where it has been stated that more water was usually lost by blowing back than was gained.

Melting the ice block, raking the bar screen, and installation of a revolving screen were considered impossible especially with a submerged crib.

An auxiliary pump has been installed on the shore. A flexible, removable intake is provided which may be attached to the pump and lowered into the water near the shore when the regular raw water intake has become clogged. The discharge is piped to the suction well of the raw water pumps. No serious ice trouble has been encountered since this pump has been ready for use so it is not known what results will be obtained.

There is some doubt as to whether the needle ice obstruction forms on the bar screen or in the intake proper. The general opinion is that it collects on the screen. However, at times, the opinion has been that it had formed in the pipe after passing through the screen. The reason for this is that sometimes when the water starts to come through it comes through with a rush bringing a slug of ice needles with it.

On the first attempt to obtain some relief by blowing-back with water, an Elyria fire department pumper was connected to the intake through a single length of 2½-in. hose line. The obstruction in the intake had built up so solidly that within one minute after the pump had been started a pressure of 80 lb. was reached. This pressure was maintained until the pump was stopped 30 minutes later. It is doubtful that a hose of this size could supply more water than would escape through the joints of the crib under this pressure, or that the bar screen would not have been blown-off if the obstruction had built-up on the screen alone.

The velocity of the water flowing through the intake seems to have some effect upon the tendency for the formation of needle ice obstruction. Previous to the construction of the new plant in 1922 it was impossible to obtain a rate of flow of more than 3 mg. per 24 hours from the raw water pumps then provided. No evidence of clogging the intake had been noticed with this limited pumping capacity. However, after the new pumping station and filtration plants were placed in operation it was not only possible but necessary to maintain a higher raw water pumpage rate during the day. Blocking of the intake by needle ice was noticed soon after that. The obstruction usually starts to form when the pumps are speeded up in the morning from the night pumpage rate of about 2 or 3 mgd. to the day rate of about 4 or 5 mgd.

DIRECT FEED CHLORINATION OF SEWAGE AT EASTON, MD.

By E. G. KASTENHUBER

Town Engineer, Easton, Md.

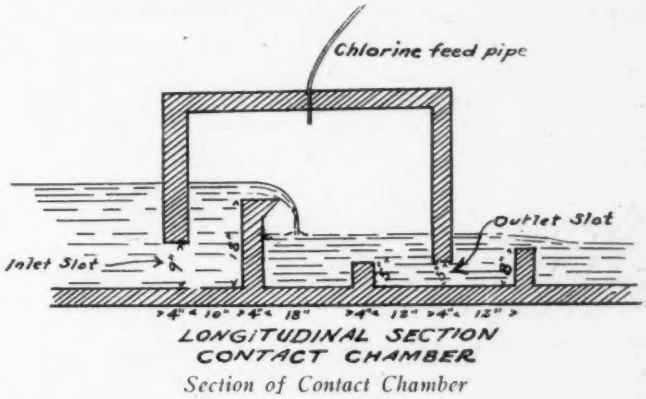
AS a result of persistent complaints from property owners, on account of odor nuisance as well as the highly polluted condition of the upper waters of a stream, and under pressure from the state department of health, the town government of Easton, Md., some months ago was forced to take some steps toward the abatement of the nuisances complained of at the two sewage disposal plants. These plants, designed twenty odd years ago, during the past decade, have become very much over-loaded and their satisfactory operation has consequently been increasingly difficult, largely because of the unwillingness of the authorities to devote anything like adequate funds for proper supervision and operation.

In the instance of one plant, rapid development of high-class residence property has extended to within a few hundred feet of the plant, while the other plant lies within 50 yards of one of the main entrances to the town, upon a major traffic artery. The odors arising at all times and particularly during periods of sludge removal from the tanks, can best be described by the layman's term, "Terrible."

Of course, the real solution of the difficulty is the ultimate abandonment of these plants and the construction of a new plant, using modern methods, at a site reasonably remote from the present corporate limits and out of the path of probable development; but under the present financial conditions, and in view of the fact that this ultimate solution would require a period of not less than two years before construction of such a new plant could be completed, the problem given the town engineer to solve was to abate the acute nuisances complained of, at the least possible cost and in the speediest manner. After some study, it was decided to try out chlorination of the effluent from both plants, and of the influent to the plant most heavily loaded.

While investigations were going forward as to the type of chlorinators to be used, the attention of the town engineer was called to a relatively new device by which the chlorine gas can be applied directly to the sewage from the cylinders in which it is commonly shipped, without the process of putting it in solution before such application. The makers of this apparatus, The Pardee Engineering Company, were called upon and after careful consideration of every phase of the situation the Easton authorities, upon the recommendation of the town engineer, decided to install this equipment, which has now been in successful operation since Aug. 21, 1931. Because of the simplicity of design, economical installation and positive realibility of this equipment, it is thought that a short description of it may be of interest to engineers and municipal officials in many places where first cost is an essential consideration and where continual expert supervision of operation is impossible or impracticable.

The chlorinator or "Chlorine Control Unit" as it is called by the manufacturers consists simply of two valves and a meter, mounted upon a wall-board of approximately 20 to 30 in. in dimension, which are connected either directly or by way of an auxiliary tank valve to the outlet valve of the chlorine cylinder. If cylinders are to be placed and unloaded one at a time, the auxiliary tank valve is not necessary, but the use of this valve at the tank outlet greatly facilitates the removal of empty cylinders, as will be explained later. The cylinders are connected to the pressure reduction valve on the board by a flexible tube connection. This valve is so constructed that it can be adjusted to reduce the cylinder pressure to any lower pressure desired within a wide range. The chlorine gas, liberated through this



Section of Contact Chamber

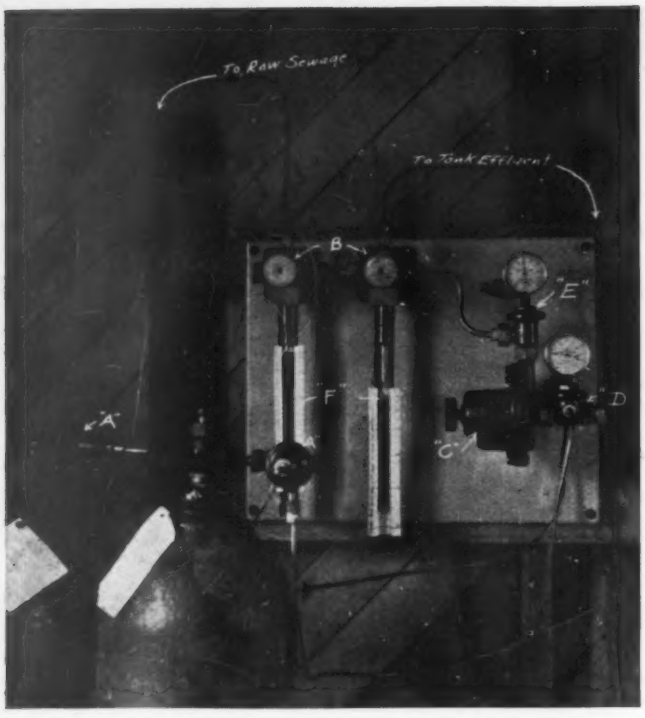
valve, passes to a control valve at the head of the meter and this control valve can be manipulated so as to release the desired quantity of chlorine to the point of application, the meter indicating, by a graduated scale, pounds of chlorine per 24 hours at a given reduced pressure.

From the meter, the chlorine is conveyed to the point of application by a silver tube inside of the housing or building. Where the point of application is remote from the building containing the apparatus, the chlorine can be conveyed through small diameter ordinary iron or steel pipe.

If more than one point of application is desired, it is necessary to install on the board a meter for each additional application, together with its outlet tube. In order to insure continuity of operation, it is practicable to connect two or more cylinders with the control unit, each of which is equipped with the auxiliary tank or cylinder valve mentioned above. By adjusting these valves to different pressures, the cylinders automatically empty themselves in rotation, as the pressure reaches the point for which the valve on each cylinder is set, and the operator by a glance at his gauge knows when any particular cylinder is empty and should be replaced by a full one.

Special Mixing-Solution Chamber Designed

Instead of the usual method of putting the chlorine in solution with water, applying this solution to the sewage and then passing the mixture through a series of baffles, weirs and orifices, commonly termed a mixing-trough,



"Direct Feed" Chlorinator at South Sewage Disposal Plant, Easton, Md.
"A": Auxiliary Cylinder Valves; "B": Meter Control Valve; "C" and "E": Feed Pressure Control and Valve; "D": Tank or Cylinder Pressure Valve; "F": Chlorine Feed Meters

the apparatus under discussion applies the chlorine directly to the sewage in a gaseous form directly from the cylinders. To accomplish this application, a gas tight chamber is constructed at any convenient point and the outlet tube or pipe from the control apparatus enters through the roof of such chamber. This chamber consists of concrete walls and roof with a slot inlet and outlet at the bottom of the respective ends. About 12 in. downstream from the inlet is constructed a weir which should be not less than twice the height of the slot. This weir is constructed with a sharp knife-edge over-hanging lip at the down-stream edge of the crest, over which the sewage to be treated passes in a thin sheet and falls to the lower level of the flow-line created by the outlet weir. It is essential that the elevation of this weir be high enough to accomplish a substantial water seal at the inlet to the contact chamber, as well as to expose the greatest possible area of sewage to contact with the chlorine gas which fills the space above. The writer believes that if the in-coming conduit is, say, 15 in. in diameter, the weir should be not less than 17 in. above the bottom or invert of the in-coming conduit. If the sewage is admitted from an open trough to the contact chamber, the top of this weir should be at least 6 in. above the top of the inlet.

About midway between this weir and the outlet slot in the down-stream wall of the chamber, is constructed a submerged weir about one-third the height of the first weir. This submerged weir aids in the thorough mixing of the chlorine with the sewage to be treated.

Not more than 1 ft. beyond the outlet of the contact chamber another weir is built across the outlet channel to a height of at least 2 in. above the top of the outlet, in order to secure a water seal at this point. From the writer's observation, it would seem advisable to increase this seal, as during periods of heavy flow there is a tendency for large bubbles containing free chlorine to escape through the outlet and intermittently break this water seal, if it is not sufficiently deep. This phenomenon has been noted several times and has been the only serious, if it can be called such, trouble so far experienced at the Easton Plants.

Results Secured

The results accomplished by this apparatus at Easton during the five months of operation have been highly satisfactory. The sewage shows a uniform absorption of chlorine at all points after treatment, and the chlorine residual in the treated sewage has been under precise control. Odors have been vastly decreased and the condition of sludge, where the raw sewage is chlorinated, prior to its entrance to the settling tanks has been much improved in quality. With this fact, it must be borne in mind that the tanks at these plants are much too small to permit of proper period of digestion and, therefore, the sludge must be removed long before the greater part of it has been well digested. The present method of chlorination has also had a marked effect in reducing odor nuisance during sludge withdrawal.

The condition of the shallow streams into which the effluent from both of these plants empties has been improved both as to appearance and odor. Operation has been continuous without any interruptions since August, 1931. The cost of operation has been very moderate. No water supply being necessary, the cost of the installation of water service, as well as the cost of the water itself, has been done away with and one or two visits a day by an intelligent attendant with occasional visits by the Town Engineer has been the only supervision required.

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Plans Completed for New Sewerage System for San Diego, Calif.

Plans for new sewer lines and mains to cost $2,300,000 and treatment works with reclamation of the water at a cost of $2,300,000 have been completed and turned over to the city engineer of San Diego, Calif.

The engineer preparing these plans took the assignment from the original bidder for the work—F. W. Seifert. The bill of $18,000 for the work is before the council awaiting approval and payment until the plans have been examined and accepted by the city engineer.

The San Diego case was an interesting one, in that the city asked for bids from consulting engineers on the work of preparing plans for sewerage and sewage treatment. The situation aroused considerable discussion in, and action by, the California sections of the A. S. C. E. The city received a single bid for the work and it was awarded F. W. Seifert but only after he had complied with the requirements of the California State Board of Registration of Engineers in assigning the work to C. G. Frisbie, a licensed engineer. In this manner the transaction was made legal.

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A. S. T. M. Appoints Committee on Water Analyses.—A Committee on Water Analyses has been appointed by the American Society of Testing Materials under the chairmanship of Mr. Max Hecht, Chief Chemist, Duquesne Light Company, Pittsburgh, Pa. This is an outgrowth of cooperation of the A. S. T. M. in boiler-water studies. The work of the new committee is to be extended to include process water used in the industrial field.

EDITORIALS

Lethal Gas

DEATHS from sewer-gas have been charged in numerous instances to exposure to carbon monoxide. That has probably been an erroneous assumption in many instances. But little, has the deadly sulphide of hydrogen (H_2S) been appreciated by sewerage engineers to be the lethal gas that it is. Only recently, two deaths at a sewage treatment works have directly or indirectly been traced to exposure of the victims to this life snuffing gas. The case in question is that of the tragic fate of a capable and well liked sewerage engineer, Earl I. Roberts, of Toledo, and Assistant City Engineer, Earnest Arnholt, at the new Lima, O., sewage treatment works of the activated sludge type with separate sludge digestion. A preliminary report of this tragedy in which the gas responsible was not named, appears on page 186, of the May issue of WATER WORKS AND SEWERAGE.

Another tragedy for which hydrogen sulphide gas was responsible occurred recently at El Centro, Calif. Andrew Jensen, a well known consulting engineer, of San Francisco, Calif., and Axel Allen, a contractor, while inspecting a disintegrating sewer were overcome by this gas and died from its effects.

An editorial, treating of "The Increasing Hazards of Sewage Disposal," appeared in the October, 1931, issue of WATER WORKS AND SEWERAGE. In this a note of caution, concerning the dangers of hydrogen sulphide, was sounded. Reference was made to the death of four workmen at the Kitchener, Ont., sewage treatment works which had been traced to their exposure to hydrogen sulphide during the cleansing of grit chambers. At a second sewage plant the aeration tanks of the activated sludge plant were actually "manufacturing" hydrogen sulphide and expelling much of it by aeration. Being a gas heavier than air it collects in sumps and low places. Experiences at Decatur, Ill., Fort Worth, Tex., and other points, supplies added evidence that underaeration, with sludge returned in a septic state, will cause the aeration units to become literally hydrogen sulphide "factories." The sulphates in the sewage water constitute the raw material and the seeding of the tanks with sulphate reducing organisms present in the returned sludge start the process of hydrogen sulphide manufacture. The limited air input seems to be conducive to the vigor of the organism attack on the sulphate ion for its oxygen content, with the consequent production of sulphides.

At Lima nothing of this sort happened. In this case the sulphide gas was produced in the heated digester and was expelled into a sampling pit through which sludge and digester supernatant liquor from the tank passed. When Arnholt was overcome by the gas he was in the act of collecting sludge samples and Roberts going to the rescue was overcome in the same pit.

This accident again emphasizes the deadly nature of hydrogen sulphide when present in sufficient concentration. Concentrations of hydrogen sulphide higher than 2,000 parts per million cause almost immediate cessation of breathing by paralysis of the respiratory center. Concentrations between 600 and 2,000 parts per million produce a different but equally deadly effect if the victim can not be removed from exposure promptly. Symptoms of poisoning develop immediately upon inhalation of the gas. Death, in acute poisoning, is as rapid as is poisoning by cyanide. Few people appreciate that hydrogen sulphide and cyanide gas have about equal lethal power. A man inhaling a high concentration of either, literally drops dead. According to Drs. Henderson and Haggard, in their book, *Noxious Gases*, concentrations of hydrogen sulphide dangerous in 30 minutes of exposure lie between 500 and 700 parts per million. Above 1,000 parts per million it is rapidly fatal. The limit of concentration for intermittent exposure in the gas-fields without real danger is reported by the U. S. Bureau of Mines to be at 200 parts per million or less. Exposure to lethal concentrations is preceded by paralysis of the nerve centers and the characteristic sulphide odor—a warning signal—is therefore not detected by the victim. Fortunately, the poisoning by sulphide inhalations is noncumulative and thus the longevity of sewage works employes is not affected by exposure to non-fatal concentrations, but workmen exposed to hydrogen sulphide have been known to suffer from "sore eyes" (Conjuctivitis) and irritation of the respiratory tract.

Digestion tank gas at Decatur, Ill., according to Dr. Hatfield, almost always contains a lethal concentration of hydrogen sulphide, which by test indicated the presence of 5,000 parts per million and Dr. Rudolfs reports higher amounts. A dilution with four parts of air to one of the Decatur digestion gas would still be a rapidly lethal mixture. The other gases from sludge digestion have no such deadly effect but in high concentrations reduce the oxygen content of the air and are therefore dangerous.

The effect of temperature plays an important role in hydrogen sulphide production and the common bacilli that produce this gas from sulphates are most active at temperatures between 78 and 90° F.—the range in which the sludge in heated digesters at modern sewage works is maintained.

To detect concentrations of hydrogen sulphide, less than sufficient to be dangerous, a rough and ready method is to expose a silver coin at the point. If hydrogen sulphide of consequence is present the coin in a very short time turns brown then black. Strips of clean polished brass will serve similarly. Paper dipped in acetate of lead (sugar of lead) solution when exposed will blacken in proportion to the concentration of sulphide gas present, and the *rate* of blackening offers a further index of relative concentration. The coin test is always available and is sufficiently positive, though not as delicate as the lead acetate test. Birds and small animals may be used to indicate the presence of any toxic gas in questionable situations and equipment is available that registers dangerous concentration.

It is time to give more serious thought to the hazards of hydrogen sulphide production in sewerage practice. Destruction of sewers and metallic appurtenances, including sludge-gas burners and furnaces, are sufficient reason in themselves but the danger of snuffing out of human lives is the more serious aspect, and particularly treacherous is a material, which in non-lethal concentration gives a nasal warning, but absolutely none when sufficiently concentrated to cause almost instant death. Designing engineers and operators must consider the chemical as well as the engineering aspects in the design and operation of modern sewage treatment works, if the hazards of sewage treatment are to be eliminated in the future. Pits and manholes, not subject to ventilation,

should be avoided in designing and every sewage works should be equipped with first aid equipment including a dependable gas-mask or hose-mask of some sort.

A resolution drawn by the Central States Sewage Works Association—May 14, 1932—contains the following statement: "That this association go on record as urging . . . the proper ventilation of manholes and enclosed places subject to the presence of sewage gases, and as urging the maintenance of gas indicators, gas-masks and suitable rescue equipment for instant use at all sewage treatment works."

Of the dangerous gases, chlorine may be considered the "rattler." It is dangerous but always gives ample warning by odor and irritation. Hydrogen sulphide gas is the "copper-head" of dangerous gases, because in lethal concentrations it cannot be smelled, and thereby gives no warning signal before it strikes.

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The President and Self-Supporting Public Works

NOW that President Hoover backed by important counsel such as Dawes, Meyers and others, has come forward with definite proposals that the Reconstruction Finance Corporation be allotted an additional $1,500,000,000 to make loans to public and private enterprise in order that utilities and public works of a self supporting or income producing character may be constructed without delay, definite steps should be taken shortly to start much needed construction by municipalities and other political subdivisions.

The relief measures proposed by Senator Wagner of New York are not far different from those of the President, and the matter of financing public works through the Reconstruction Finance Corporation is practically identical. Senator Wagner's proposal has essentially the approval and backing of the Secretary of the Treasury.

Whatever may be the outcome—whether it be the plan of Mr. Hoover and his counsellors, or that of Mr. Wagner—is immaterial to municipalities needing financial assistance now unobtainable through the usual channels. The main point is that one or the other measure seems assured of passage into law by Congress shortly. Even now the effect of the improved situation is being felt throughout the country and the resignation of Mr. Dawes from the directorship of the R. F. C. indicates to those who know him best that he feels that the procedure from this point is a matter of mechanical handling of the financial assistance to be shortly available.

It really looks as though municipalities can now begin definitely to proceed with the needed new construction or improvements in water works, sewerage and other needed utilities or public works which can be placed on a self supporting basis,the financing to be done under this emergency appropriation.

If it is a matter of "first come first serve" it behooves city authorities to act quickly in respect to securing the assistance needed from the Reconstruction Finance Corporation.

L. H. Enslow

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Southern California Rainfall Since 1769

A REPORT on Rainfall and Stream Run-off in Southern California has been published by the Metropolitan Water District, Los Angeles, copies of which are to be had free of charge. Although the report contains only 32 pages, it embodies the results of 5 years of labor on the part of its author, H. B. Lynch, Consulting Engineer.

No rain-gage records in California are available prior to 1847, but Mr. Lynch undertook to build up an approximate rain curve prior thereto and back to 1769, based on historical data, and crop yields. The Spanish missionaries arrived in California, May, 1769, and in 1774 began to keep annual crop records, which were continued for 60 years. These records furnish an excellent means of determining the relative amount of rainfall, in addition to which the padres left many written comments on the weather.

Some idea of the painstaking thoroughness of Mr. Lynch may be had from reading the citation of references in his bibliography. Fully 100 different authors are there listed.

Thirteen years ago the Carnegie Institute of Washington published a monograph by Prof. A. E. Douglass, giving tables of ring thickness of California giant redwood trees, by years back to 1306 B. C., and of Arizona pines back to 1392 A. D. He has recently carried the Arizona pine measurements back to 700 A. D., by using logs in ancient dwellings of Indians. The only other published record of tree-ring measurements by years in California is in a monograph by Shreve, "Growth Record in Trees," published by the Carnegie Institution, 1924. Shreve's measurements relate to a Monterey pine, near Carmel, from 1884 to 1921. He made measurements of the rings at different heights above the ground. In Civil Engineering, February, 1932, John Harland gave a table of annual tree-ring thickness at Cibecue, Arizona, compared with rainfall at Fort Apache, for the years 1906 to 1917. He also gave a graph comparing annual tree-ring thickness with annual run-off for 30 years. We cite these tree-ring records so that hydraulic engineers may compare the Southern California rainfall curve derived by Mr. Lynch's methods with curves of tree-ring thickness in California and Arizona.

Because the Weather Bureau reports of Los Angeles rainfall go no farther back than 1878, it is probably not known to many engineers that gage records in or near Los Angeles are available back to 1864. These earlier records are given by Mr. Lynch.

The earliest gage record on our Pacific Coast starts in May, 1842, at Sitka, Alaska. The earliest gage record in America starts in January, 1738, at Charleston, S. C. These last two, and many other rainfall records by months, are given in "World Weather Records," which can be had for $1 by addressing The Smithsonian Institute, Washington, D. C. In that monumental book will be found also monthly rainfall records at San Diego, Sacramento and San Francisco back to 1849

Engineers of the Los Angeles water department have measured the tree-rings of many trees in the Owens River district, in order to find, if possible, evidence of rainfall cycles. It is to be hoped that these measurements will be published soon.

W. P. Gillette

▼

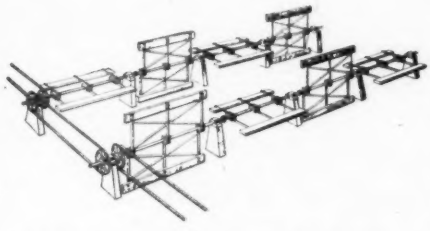
We regret very much that lack of space prevents us from including in this issue an account of the joint meeting of the Central States Sewage Works Association and the Illinois Association of Sanitary Districts. A full report of this meeting will appear in the July issue.

NEW EQUIPMENT AND MATERIALS

The Dorrco Flocculator

The Dorrco Flocculator, introduced in the municipal and industrial water treatment fields by The Dorr Company, Inc., is adapted equally well to the requirements of water softening and coagulation and may be installed in existing sedimentation tanks as well as in new ones. A new principle is employed for the more complete utilization of the chemical reagents, for the promotion of rapid floc formation, and for the entrainment of colloidal solids. Consequently, as a result of the continuous recirculation of sludge provided in this principle, less chemicals are consumed and the heavy flocs formed display improved settling characteristics, enabling the sedimentation tanks to yield either a clearer water than formerly or else handle a greater volume of water at the former degree of clarity.

In existing plants, using a number of rectangular sedimentation tanks, the flocculators are installed transversely across the tanks, close to the influent end. Where the plant is a new one or where mechanical clarifiers are to be used, the flocculators may best be installed in separate tanks, close or adjacent to the clarifier tank.



The Dorrco Flocculator, Duplex Type.

The Dorrco Flocculator consists of a number of paddle wheel assemblies mounted on and rotating with a steel shaft in the tank. The paddle blades are paraffined wood, attached to the ends of radial steel arms, and are supplemented by diagonal blades to prevent the formation of dead or quiescent zones around the shaft. The shaft is supported between paddles by bearings resting upon concrete or steel columns and is driven by a variable speed motor and speed reducer. Each paddle-wheel assembly is oriented 90 degrees out of phase with adjacent units to minimize surging and to give better dynamical balance.

Except at very small plants a number of flocculators are used, the shafts being arranged parallel to one another and with the water that is being chemically treated passing by them in series. The shafts all rotate in unison and in the same direction, being interconnected by chains and sprockets and driven by a single, variable-speed motor and speed reducer.

The paddle blades of multiple units of this type are so arranged as to provide a progressive diminution in the intensity of agitation as the water passes through the unit. Thus the treated water is given, first, a relatively rapid mixing for the dispersion of reagents and, second, a progressively milder agitation to promote flocculation and the growth of these flocs to uniform agglomerations of greater size. This feature is distinctive and is known as tapered or decelerated flocculation.

Continuous recirculation of flocs and sludge is an inherent feature of this flocculator, but the unique feature of this machine is the accomplishing of this objective without destroying or damaging the floc structure.

The Dorrco Flocculator is offered in the simplex type, one row of paddles in a single tank; duplex type, two rows of paddles in a single tank; and multiplex type, three or more rows of paddles, either in a single tank or in the feed end of a sedimentation basin. Two installations have been made—four multiplex units at Richmond, Va., and eight duplex units, not yet in operation, at Hamilton, Ont.

The installation at the Richmond, Va., waterworks consists of four quadruplex flocculators, consisting of four rows each of paddles 8 ft. 9 in. in diameter and 63 ft. 9 in. long, installed in the influent ends of four settling basins 150 ft. long. Each of these four flocculators is driven by a 3 H. P. variable speed motor, directly connected to a speed reducer, and provided with a controller giving four different speeds.

For further information address The Dorr Co., 247 Park Ave., New York, N. Y.

▼

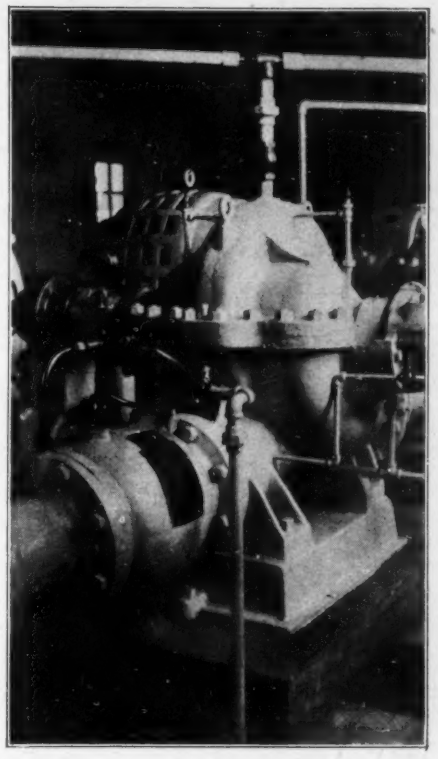
Baldwin-Southwark Corp. Brings Out New Valves

The Southwark Division of the Baldwin-Southwark Corporation, Philadelphia, announces the addition to its already wide line of hydraulic valves, of a group of valves especially designed for the field of water works and hydro-electric power generation.

This line of valves has been newly developed by Southwark to assist water works engineers in solving some of the difficult problems met in handling water at high velocity through long pipe lines, and to eliminate dangerous pressure surges and water hammer conditions.

The Larner-Johnson, internal cylinder, balanced plunger principle is employed in the design of many of these valves, which includes slow-closing check valves having an adjustable rate of closure, pressure regulators which function without oscillation or "chugging," surge suppressors which involve an entirely new principle of operation, altitude valves, automatic air valves, throttling valves and automatic gate valves. They are available in all sizes.

A bulletin descriptive of this line is ready for distribution, and requests for copies will be promptly granted. Give name, company (or municipality), position (or office) and address.



Check Valve Mounted at Outlet of a Centrifugal Pump.

▼

New Model Water Meter Introduced by Worthington

Having commercially manufactured various types of water, oil, gasoline and grease meters for the past 75 years, the Worthington Pump and Machinery Corporation, Harrison, N. J., recently has added another model of water meter to its already extensive line. This meter, known as the Model GA, is built in sizes from ⅝ to 2 in., with normal flow limits from 1 to 160 gal. per minute. These new meters are stated to incorporate many unusual features.

Of the positive displacement disc type, all register gears are fitted with rubber-bushed bearings. The register box, of heavy construction, is fitted with a double lid to facilitate cleaning of the cover glass. The train assembly comprises four cast bronze gears and four pinions, all rigidly fastened to Monel metal spindles which revolve in replaceable hard-rubber bushings. Although standard construction provides an inclosure for oil, the train easily may be converted to the open type by the substitution of an open train plate—removal of three screws releasing the train from the main case.

The disc or measuring chamber is in two sections, held together by a snap joint without screws. This construction permits the case to separate without distortion in the event of freezing. Additional protection is secured by the use of a cast-iron frost bottom on the three smaller meters. Though sufficiently strong to withstand the pressures encountered in regular service, this bottom breaks when the water in the meter freezes. This relieves the strain on the interior parts and prevents damage to the meter. Replacement of the bottom at nominal cost makes the meter again ready for service.

A particularly interesting feature of these new meters is the location of the stuffing box. This is cast on the main case instead of being a part of the train or register box. This eliminates a source of possible leakage as no gaskets or lock nuts are necessary.

New Pump for Handling Sewage

A new pump for handling sewage and storm water or for general drainage or condenser circulating service, is announced by Morris Machine Works of Baldwinsville, N. Y. A feature of special interest in this pump is the propeller, which is of the screw type with vanes somewhat similar to those of a ship's propeller. This distinctive propeller has two important characteristics for these services. In the first place, the widely spaced open vanes permit passing solids of large size without danger of clogging. In the second place, the design permits delivering large quantities of water at low heads when operating at comparatively high rotative speeds, so that on low head services the pump is better suited for direct motor drive than are standard centrifugal pumps.

New Morris Pump

These pumps are claimed to be exceptionally efficient. It is stated that a 42-in. pump, for example, showed an efficiency of more than 85 per cent on plant test when delivering 45,000 g.p.m. against a total head of 22½ ft., operating at 600 r.p.m.

The casing has a large handhole opening for inspection of the interior and is provided on both sides with renewable discs which are accurately machined for close clearance with the propeller. Special attention has been given to the design of the bearings to provide ample support for the shaft and complete counter-balance of end thrust. These pumps are built in sizes 16 in. and larger, and for either horizontal or vertical drive.

WITH THE MANUFACTURERS

J. R. Schmertz of Mathieson Alkali Works Honored By T. P. A.

Jack Schmertz, manager of advertising of Mathieson Alkali Works, New York, has recently been elected president of the Technical Publicity Association—the oldest organization of its kind in the field. The object of this association is to maintain publicity and, in particular, advertising in the technical fields on a high plane. Schmertz has served the association in other official capacities, but is probably the youngest man ever to have reached the presidents' chair in this long established organization.

J. R. Schmertz, Advertising Manager, Mathieson Alkali Works.

Dr. Edwards Now Research Engineer for Dow Chemical Co.

Dr. Gail P. Edwards has recently joined the Technical Sales Division of the Dow Chemical Company of Midland, Mich., specializing in the development of ferric chloride for sanitary purposes. Dr. Edwards received his Ph.D. from the University of Illinois in 1923. During the war he was in the Water Supply Service of the American Expeditionary Forces in France. He was chemist for the Illinois Water Survey, 1919 to 1923 and from 1923 to 1932 he was research chemist for the Sanitary District of Chicago. For the past year he has been working with ferric chloride, especially as applied to the filtration of sewage sludges at Chicago.

The Dow Chemical Company have been supplying crystal ferric-chloride in the sewage field for some time and now are also supplying this efficient coagulant and conditioning agent in the liquid form, such as is used at the Milwaukee, Indianapolis and Pasadena sewage treatment plants, and at Los Angeles, Beverley Hills, Calif., and at other points as a water coagulant.

Gail P. Edwards, Research Engineer, Dow Chemical Co., Midland, Mich.

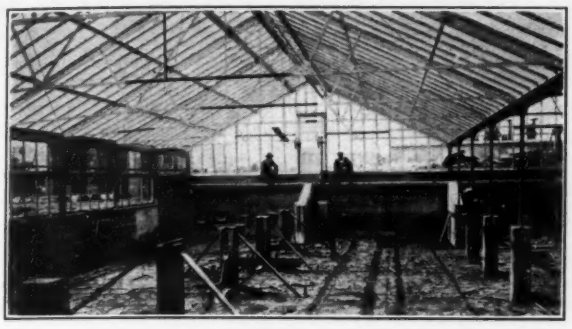
R. D. Mahaffey, of American Well Works, Dies

This is to advise that R. D. Mahaffey, vice-president and treasurer of The American Well Works, Aurora, Ill., died at his home June 3rd after an illness of several months. He was born Nov. 2, 1866, at Hinckley, Ill.

Mr. Mahaffey has been identified with The American Well Works and the pump industry for a period of 43 years, having started with the company as office boy and by hard work and energy attained the position of treasurer and later the vice-presidency of the company. He was a past president of the Hydraulic Society, vice-president of the Home Building & Loan Association of Aurora, Ill., director of the Chamber of Commerce and was a charter member of the Union League Club, as well as other civic and social associations.

He leaves a wife and daughter to mourn his loss, as well as a vast host of friends and associates.

Glass-Overs for Sludge Beds



About Camden, N. J.
North Sewage Treatment

ENGINEERS were Remington, Vosbury and Goff. Capacity of plant is 3 million gallons. The outfit consists of intercepting chamber, grit chamber, pumping station, Imhoff tank. For drying of sludge there are two Lord and Burnham Master Construction Glass-Overs, each 30 x 50 feet. This Master Construction has several superior features giving it distinct advantages. Full information gladly supplied.

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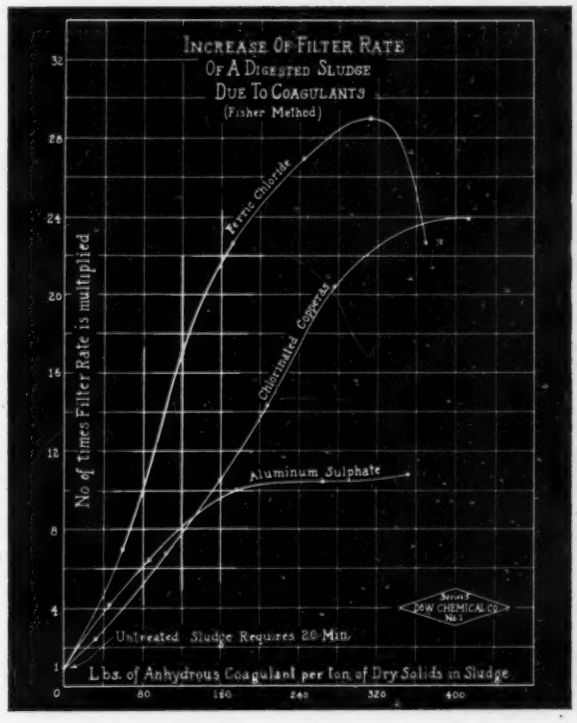
Increase Of Filter Rate
Of A Digested Sludge
Due To Coagulants
(Fisher Method)
No of times Filter Rate is multiplied
Ferric Chloride
Chlorinated Copperas
Aluminum Sulphate
Untreated Sludge Requires 20 Min.
Lbs. of Anhydrous Coagulant per ton of Dry Solids in Sludge
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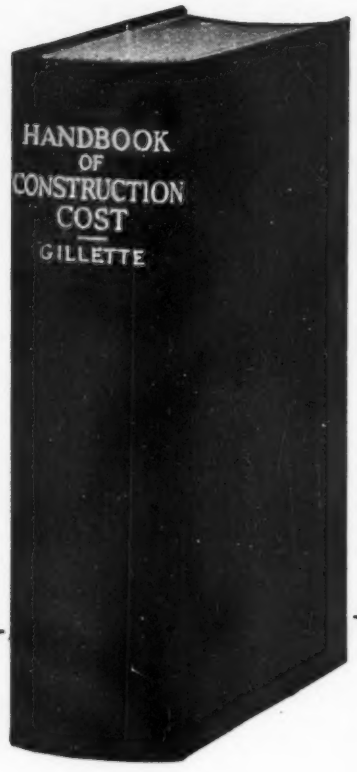

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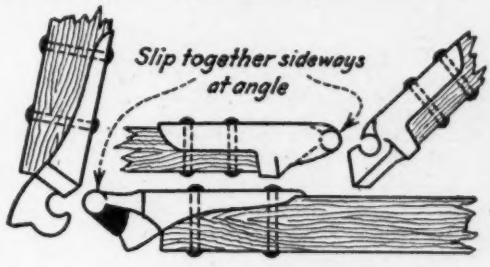

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M. A. IN CHEMISTRY from prominent university wants position as chemist or plant operator. Over three years' experience as chemist, chiefly on water and foods. Age 26. Any location. Moderate salary. Good references. Box 6002, Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

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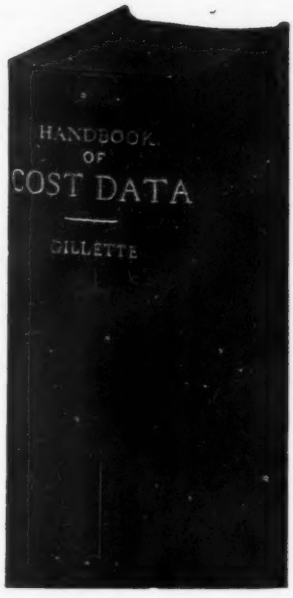

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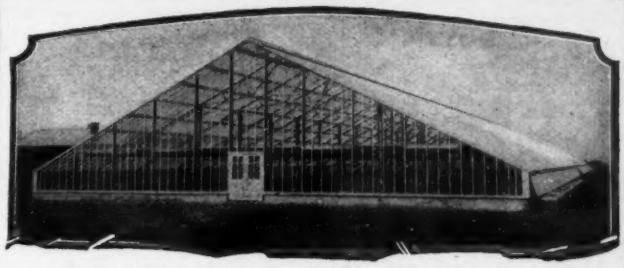

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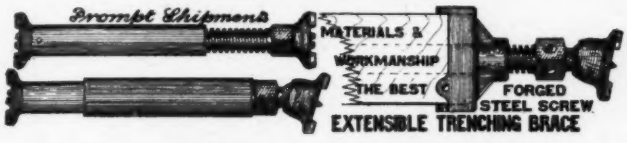

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South Yonkers Treatment Plant
Westchester County Sanitary Sewer Commission

This modern treatment plant contains a Morse Boulger Screenings Destructor having a capacity of one ton per hour. Its location near a fashionable girl's school and large orphan asylum required that incineration be absolutely without smoke or odors.

A similar Morse Boulger Destructor has been installed at the Mamaroneck Plant of the Commission.

INCINERATE SEWAGE SCREENINGS

FOR COMPLETE FINAL DISPOSAL

Sewage screenings are of a highly offensive nature and require immediate disposal. Composting, digestion, dumping, burying and barging are all means available in some localities and at some seasons of the year for getting the screenings out of sight. However, they do not provide complete final disposal.

Incineration is the only means of regular and complete disposal of screenings without nuisance. It is available to every treatment plant regardless of location and is a permanent solution to the disposal problem for the life of the plant.

The Morse Boulger Destructor Company has for over thirty-seven years been engaged exclusively in the design and manufacture of heavy-duty incinerators for all purposes. Hundreds of Destructors, burning every conceivable type of waste are in daily operation throughout the world. This company therefore brings to the sewage field a wealth of knowledge and experience in the general problem of incineration.

Screenings Destructor at Sewage Treatment Plant, Reading, Pa.

This Destructor is used for the disposal of coarse screenings. The fuel used is oil—burners to be supplied by the City.

During the last several years a considerable amount of experimenting and testing has been done on the incineration of sewage screenings. As a result of this work Destructors have been perfected which have been proven to be economical, efficient and practically foolproof in operation at this difficult task. Every Destructor is guaranteed to operate at capacity without nuisance from smoke and odors. They can be located inside or outside of buildings and can be installed in existing treatment plants at low cost.

Morse Boulger Destructors in daily operation in sewage treatment plants range in capacity from 65 pounds per hour to 24 tons per day. Representative installations may be seen in a number of localities.

Westchester County Sanitary Sewer Commission
W. W. YOUNG, Consulting Engineer
South Yonkers Plant ..... 2000 lbs. per hour
Mamaroneck Plant ..... 2000 lbs. per hour
Saw Mill River Plant ..... 2000 lbs. per hour

Milwaukee Sewerage Commission
JAS. L. FEREBEE, Ch. Eng.—T. CHALKELY HATTON, Cons. Eng.
Jones Island Plant, Two Destructors ..... 3333 lbs. per hour

Third Forks Disposal Plant
GILBERT C. WHITE CO., Engineers
Durham, N. C. ..... 160 lbs. per hour

Reading, Pa. ..... 65 lbs. per hour
REMINGTON, VOSBURY & GOFF, Engineers

Borough of Pottstown, Pa. ..... 125 lbs. per hour
WM. H. DECHANT & SONS, Engineers

Traverse City, Michigan ..... 65 lbs. per hour
HOAD, DECKER, SHOECRAFT & DRURY, Engineers

Information concerning the incineration of sewage solids will be sent on request.

HEAVY-DUTY INCINERATION
MORSE BOULGER DESTRUCTORS

205 East 42nd Street New York, N. Y.

PURE WATER
.. BUILDER OF CITIES
Hiawatha's magic lives
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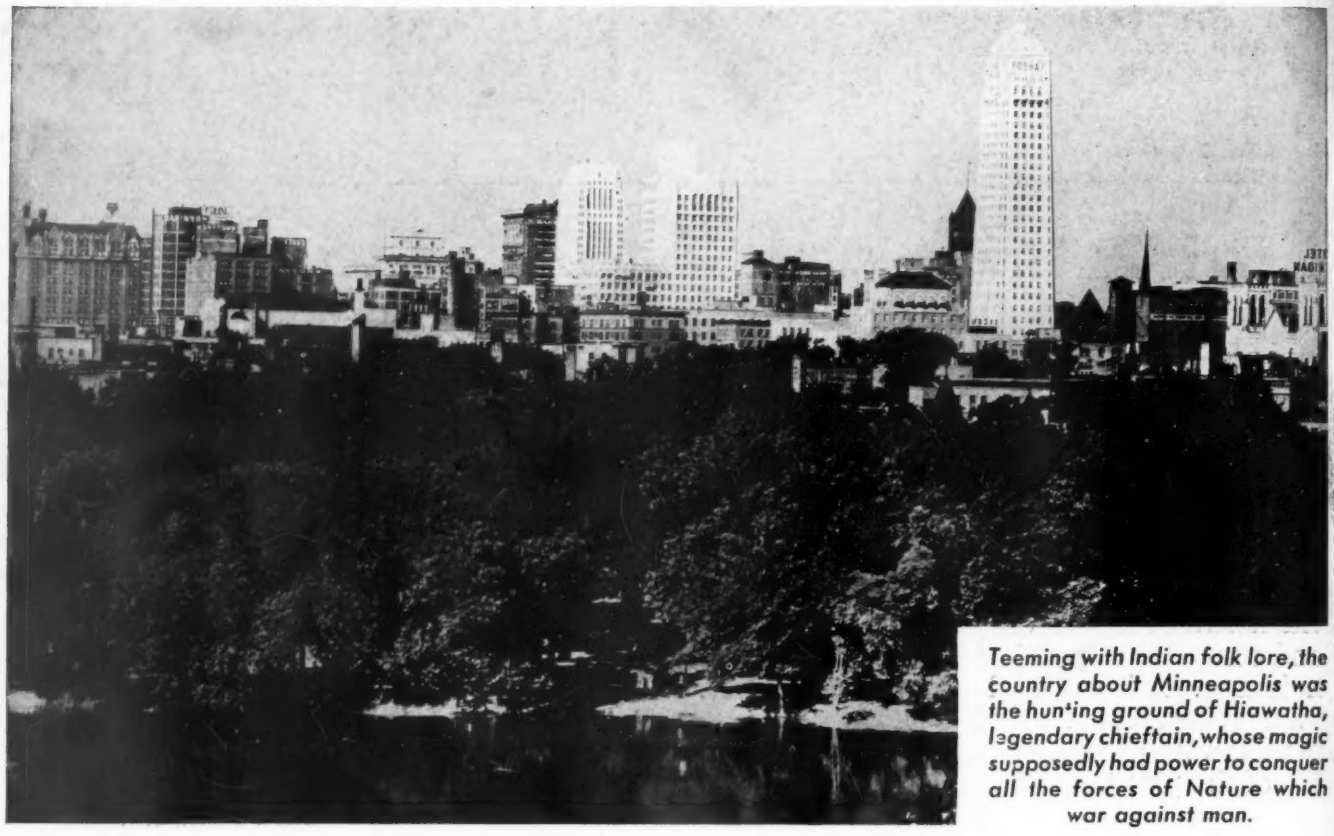
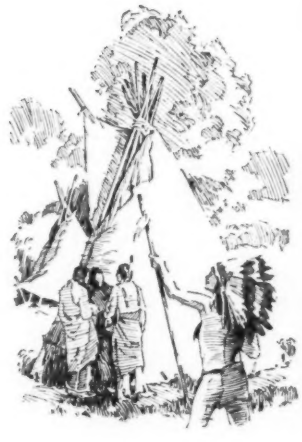


Teeming with Indian folk lore, the country about Minneapolis was the hunting ground of Hiawatha, legendary chieftain, whose magic supposedly had power to conquer all the forces of Nature which war against man.

BUT no longer does Minneapolis trust to magic arts to preserve the purity of its water supply. Sterilization with two W&T chlorinators was begun in 1915. Two more were added in 1918, two in 1919 and two in 1920.

Then—in 1922 W&T Vacuum Chlorinators assumed the work of disinfecting the polluted Mississippi water. Four times since, as water requirments increased, Minneapolis ordered additional units of this type until now the two filter plants—Columbia Heights and Fridley—use 13 W&T Vacuum Chlorinators—13 unfailing safeguards against water borne disease in Minneapolis today.

Low maintenance costs, consistent accuracy, simplified operation and unfailing performance justify this trust in W&T Vacuum Chlorinators. Your supply deserves the same positive protection. Technical Publication 38 describes these chlorinators in detail. Ask for your copy.



WALLACE & TIERNAN CO., Inc.

Manufacturers of Chlorine and Ammonia Control Apparatus

Newark, New Jersey
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Main Factory:
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Other W&T Chlorinators—17 more—sterilize private and public pools, disinfect sewage and perform allied services on installations other than those under jurisdiction of the Water Department.

SA 44

"The Only Safe Water Is A Sterilized Water"

ABC

A GILLETTE PUBLICATION

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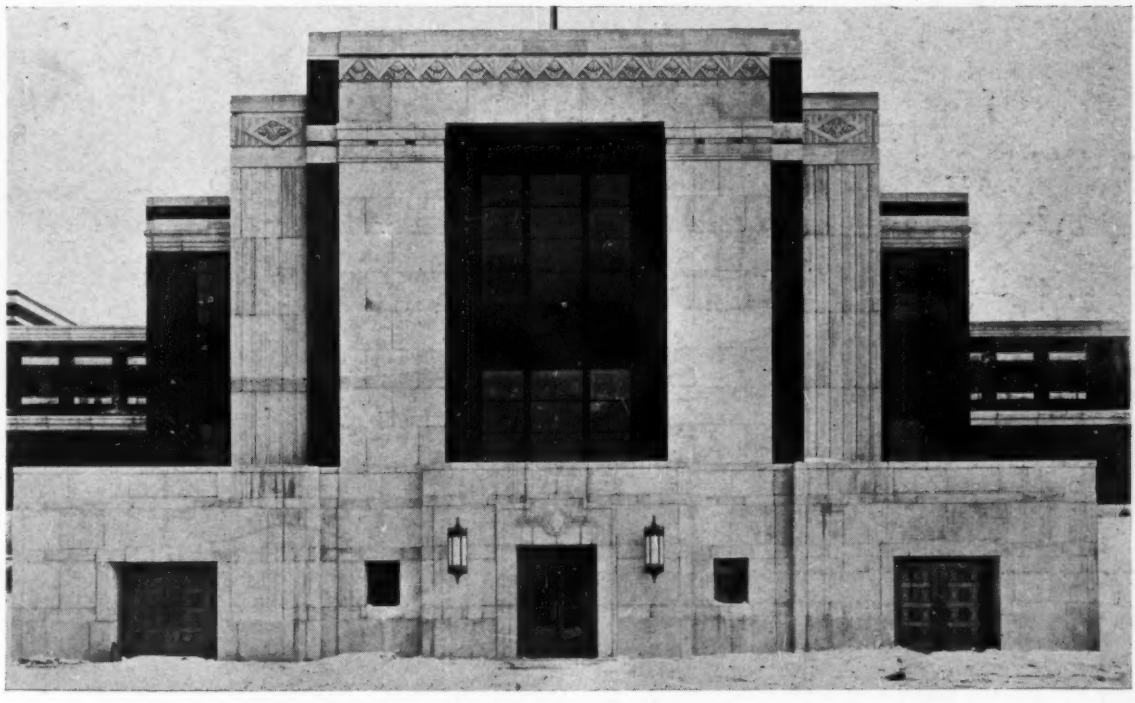
July, 1932 — L. H. Enslow, Editor — Vol. LXXIX. No. 7



Administration Building of New Filtration Plant of Ottawa, Ont.

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Water Supply in the Paper Industry

Filtration of Sewage Sludge

Sludge Disposal at Baltimore, Md.

Reports of Meetings of 4 States Section A.W.W.A., Central States Sewage Works Association and New York State Sewage Works Association

HTH...helps overcome taste and odor due to algae

Sedalia Water Co. gets "very satisfactory results" by using HTH in filter beds...

SEDALIA WATER COMPANY
L. P. ANDREWS, MANAGER
SEDALIA, MO.

March 28, 1932.

Mathieson Alkali Works, Inc.,
250 Park Avenue,
New York, N. Y.

Gentlemen:

During the late summer of 1931, at a season when we find it hard to overcome the tastes and odors due to algae growth in our surface water supply, we purchased a supply of your H T H product for experimental purposes.

We derived very satisfactory results in using this material as per your instructions in freeing the sand in our rapid sand filter beds of accumulations of algae. The algae thus killed was easily removed when filters were washed, restoring the filter beds to their normal capacity.

We are recommending H T H to our swimming pool operators as a sterilizing agent of convenient form and moderate cost.

Yours very truly,
SEDALIA WATER COMPANY
L. P. Andrews
President & Manager.

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A Superior Product for Convenient and Accurate Preparation of Bleaching and Sterilizing Solutions
Stable — Readily Soluble — Uniform Concentrated
The HTH in this package contains 2½ lbs. Available Chlorine
Manufactured by
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